Engineering Library

NOV 2 1931

ASA BULLETIN

NOVEMBER, 1931 NUMBER 67

Quality of Surface Finishes:

Standard Classification of Quality of Finish of Machine Surfaces 3
by John Gaillard

A Survey of Surface Quality Standards and a Study of Tolerance Costs 4
by R. E. W. Harrison

The Establishment of Standards for Machine Finishes 22
by R. C. Deale

New Electrical Committee Holds Organization Meeting 29

ASA Projects 32

A Review of Safety Code Projects under ASA Procedure 32

Personnel of Committee on Insulators Approved 39

PUBLISHED MONTHLY FOR THE SUSTAINING MEMBERS OF THE AMERICAN STANDARDS ASSOCIATION, 29 WEST 39TH STREET, NEW YORK

ASA MEMBER-BODIES

Am. Electric Railway Assn.
Am. Gas Assn.
Am. Gear Mfrs. Assn.
Am. Home Economics Assn.
Am. Institute of Architects
Am. Institute of Elec. Engrs.
Am. Institute of Mining & Metallurgical Engrs.
Am. Mining Congress
Am. Railway Assn.
Am. Soc. of Civil Engrs.
Am. Soc. of Mechanical Engrs.
Am. Soc. for Testing Materials
Assn. of Am. Steel Mfrs. Technical Committee
Cast Iron Pipe Research Assn.
Electric Light and Power Group;
  Assn. of Edison Illuminating Companies
  Nat'l Electric Light Assn.
Fire Protection Group:
  Associated Factory Mutual Fire Insurance Companies
  Nat'l Board of Fire Underwriters
  Nat'l Fire Protection Assn.
  Underwriters' Laboratories
Institute of Radio Engrs.
Internat'l Acetylene Assn.
Light Metals Group:
  Aluminum Co. of Am.
Mfrs. Standardization Soc. of the Valve and Fittings Ind.
Nat'l Assn. of Mutual Casualty Companies
Nat'l Bur. of Casualty and Surety Underwriters
Nat'l Coal Assn.
Nat'l Electrical Mfrs. Assn.
Nat'l Machine Tool Bldrs.' Assn.
Nat'l Safety Council
The Panama Canal
Radio Mfrs. Assoc.
Small Tools Group:
  Drill and Reamer Soc.
  Milling Cutter Soc.
  Tap and Die Institute
Soc. of Automotive Engrs.
Telephone Group:
  Bell Telephone System
  U. S. Independent Tel. Assn.
U. S. Department of Agriculture
U. S. Department of Commerce
U. S. Department of Interior
U. S. Department of Labor
U. S. Govt. Printing Office
U. S. Navy Department
U. S. War Department

OFFICERS

Bancroft Gherardi	*President*
Cloyd M. Chapman	*Vice-President*
P. G. Agnew	*Secretary*
Cyril Ainsworth	*Assistant Secretary*

Arthur Kallet	*Editor*
Ruth E. Mason	*Assistant Editor*
F. J. Schlink	*Contributing Editor*

Standard Classification of Quality of Finish of Machine Surfaces

The American Society of Mechanical Engineers asks ASA to initate project to deal with this subject

What is a good "commercial" ground finish? How does the quality of a lapped surface compare with a finely ground one? Questions like these are representative of a more general problem whose importance has been growing in recent years: namely, the establishment of a basis of measurement for the quality of finish of machine surfaces. Such basis of measurement would make it possible to classify different machine finishes, to compare them, and to designate them on shop drawings and in specifications by a standard number, symbol, or term.

Quality of surface is, among other things, a major factor in the fitting together of parts. This applies in the first place to clearance fits—such as the fit between a shaft and its bearing—where surface quality influences the wear of the parts. The modern tendency is to give cylindrical parts which have to function under exacting conditions a good quality of surface finish before assembly, instead of following the old practice of letting them obtain such finish during a "running-in" period of the assembled machine. Surface quality also determines the maximum resistance which parts with a tight fit will offer to an effort to separate them. Furthermore, quality of finish is a matter to be considered in many cases where no problem of fit is involved, but where a certain appearance of the manufactured product is required. Viewed in general, the problem applies to surfaces of all kinds—cylindrical, flat, or otherwise—and to the different kinds of machine finishes used in manufacturing practice. Actually, it also applies to finishes obtained by processes not involving the removal of metal; such as cold rolling or drawing, press-finishing, etc.

According to the experience of the ASA office, the need for some kind of classification has been more particularly felt, in the last few years, by the manufacturers and users of grinding equipment. Quality designations like "rough," "commercial," "smooth," "fine," "mirror," "extra," "ultra," have been adopted by individual companies, but such terms are more likely than not to have a different meaning in each organization. Moreover, in so far as they are not tied down to measureable properties, they can be interpreted only by means of samples. Sets of such samples—also of finishes other than ground ones—are actually used by several firms as a guide for their engineering, production, and other departments. In the meantime, interesting work has been done, both in this country and abroad, toward a fundamental solution of the problem on the basis of measurement.

After preliminary discussion by the groups concerned, the matter was referred to the American Society of Mechanical Engineers, and this Society in turn recently laid it before ASA with the request that a sectional committee be organized under ASA procedure to deal with "standard finishes of machine surfaces." In so doing, the A.S.M.E. offered to act as sponsor or joint sponsor for the new project. A special committee has been appointed to make a recommendation to the Standards Council concerning the request of the A.S.M.E., this recommendation to include the questions as to whether the project should be undertaken, and if so, what organization or organizations should be sponsor or sponsors. This special committee is made up as follows:

Major William B. Hardigg, U. S. War Department, chairman

Frank R. Henry, Grinding Wheel Manufacturers Association of the U. S. and Canada

F. O. Hoagland, National Machine Tool Builders' Association

C. B. LePage, American Society of Mechanical Engineers

C. B. Veal, Society of Automotive Engineers

If the Standards Council, upon recommendation of this committee, decides that work on the project shall be started, the sponsor or sponsors will organize a sectional committee consisting of representatives of all major groups having an interest in the project.

For the information of those interested in quality of surface finishes, the ASA BULLETIN presents on the following pages reprints of two important papers on this subject.

JOHN GAILLARD

A Survey of Surface Quality Standards and a Study of Tolerance Costs[1]

by

R. E. W. Harrison, *Engineering Director*
Cincinnati Grinders, Inc.

A proposal for a method of measuring surface quality, with an appendix on microscopical examination of cross-section of surfaces[2] by Dr. C. B. Sawyer

The urge for betterment which leads to perfection brings our past performances under the most critical review. Sometimes this is the result of failure measured in terms of longevity or the inability of some mechanical piece of work to fulfill its function; sometimes it is the urge of the designer to produce a more mechanically perfect and lasting job; sometimes it is the desire of the production engineer to excel in his art and produce something better than that which has gone before; and it is often the urge brought about by intensive competition which makes it a commercial necessity for one individual or concern to produce something better than that which has hitherto been presented in an endeavor to capture a market and its attendant profits.

Whatever the cause may be, the fact remains that the world is marching steadily forward. While the credo of many manufacturers is to make and produce within the widest permissible limits of accuracy and finish consistent with the established standards of efficiency for their product, there are others, and these latter probably constitute the majority, who, with a genuine desire to produce a better job, strive all the time to improve on past performance.

Ever since the first lathe and the first boring machine, and in fact the first tool of any of the now-established types, were put into operation, the finish and accuracy of their product have been matters of speculative discussion.

There, of course, has always been a compromise between the practical and the ideal. But although it is invariably conceded that perfection is unattainable, this fact has never prevented striving for that goal.

This paper represents an endeavor on the part of the author to record, in a useful way, some of the progress which has been achieved up to date.

[1] A paper presented at the Annual Meeting of the American Society of Mechanical Engineers, December 1–5, 1930.

[2] See page 12.

Section A

1

Surface Irregularities on Ground and Lapped Work

The fact that so many engineers supplement their eyesight with eyeglasses and spectacles is in itself evidence of a growing dissatisfaction with the limitations of the naked eye. Hence the author feels confident that no one will feel that the discussion is being made of too academic a nature if the microscope is accepted as a highly desirable and, in many cases, necessary tool in the inspection department; for, without the aid of this tool, the naked eye is insufficient to gage qualities of surfaces called for by present-day standards.

A simple experiment with a camera, photographing a piece of ground work, will be sufficient to convince the most skeptical that the sight of the average individual can be deceived to a surprising and disconcerting extent.

The outside diameter of an eight-inch diameter ball race, when viewed by the naked eye, appeared to have a highly satisfactory surface, as shown at A in Figure 1. It, however, took on a quite chattered or broken appearance, as shown at B, when photographed. This photograph is not an enlargement and represents the actual size of the work.

It might be argued that in the quest for the true plane surface one is getting out of the realm of practical workshop possibilities and introducing laboratory methods and discussions. But, in the author's opinion, the answer to this is the increased mileage available on the modern automobile due to the higher initial finish and accuracy built into the components generating the power and carrying the load, as compared with the relatively short total of mileage and noisy, inefficient performance of the automobile of even three years ago.

That there is an appreciation of the fact that

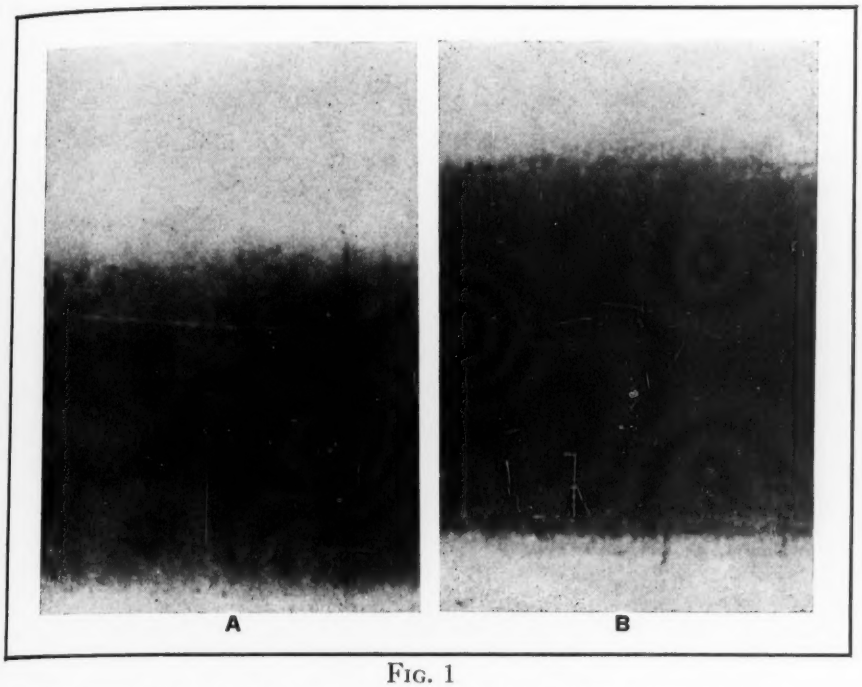


FIG. 1

The Same Piece of Work: A, as Viewed with the Naked Eye; B, Defects Revealed by the Camera

minute surface irregularities result in rapid wear, irrespective of lubrication, and that there is a definite though now limited market for the near-perfect piece of mechanism, is borne out by the fact that there are a few automobile manufacturers who have built up a profitable business by building this type of mechanism only.

It is generally known and accepted that the method of removing metal which involves the use of a hardened tool, the nose of which penetrates the surface to be machined to the required depth, leaves a relatively torn and disrupted surface which has a high coefficient of friction and a relatively high initial wear.

It is not proposed in this paper to discuss the relative merits of machined and ground work, but to deal with the finer irregularities produced by the accepted finishing operation of today: i.e., grinding. Whether the work be hardened or soft, or cast iron, steel, or bronze, it has been proved that the cheapest way of securing accuracy within the closely specified limits, and finish up to an acceptable standard, is by means of the precision grinding machine. This, then, is the starting point.

The modern grinding wheel, which is built up from an accurately sized, accurately spaced, and carefully bonded abrasive, is in itself a tool of precision, produced by its makers to within limits of accuracy controlled within thousandths of an inch. Examined by the naked eye after being mounted and trued in a modern precision machine, the working surface of this wheel presents a smooth and precise appearance. However, when this wheel and the work on which it is operated are viewed through the microscope, it will be realized that modern precision grinding is nothing more or less than a closely controlled milling operation in which each of the particles of abrasive presented to the work plows its quota of metal and leaves its resulting furrows.

While one may overlap and overlap the path taken by succeeding particles of abrasive, the resultant surface under a powerful microscope has much in common with a plowed field, Figure 2. Sharp ridges of steel or iron exist on the surface of the work, and these must be removed before one can arrive at a plane surface which will have a maximum resistance to wear.

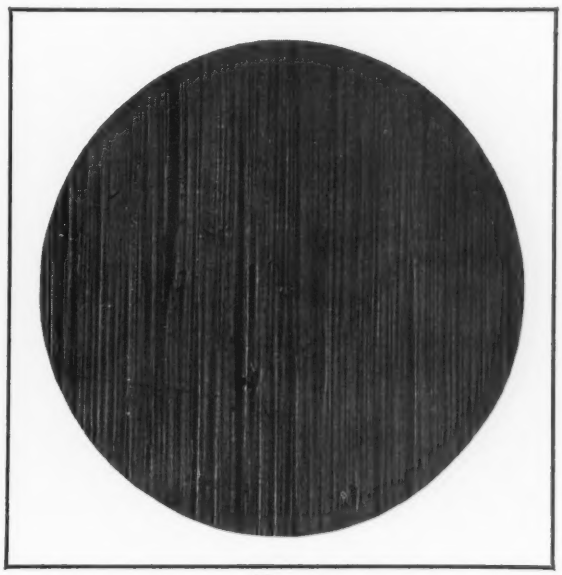


FIG. 2

Photomicrograph × 75 Surface of Cylinder Ground to Generally Acceptable Finish with 80-Grit Wheel

Some few years ago the research engineer of one of the automobile concerns making cars

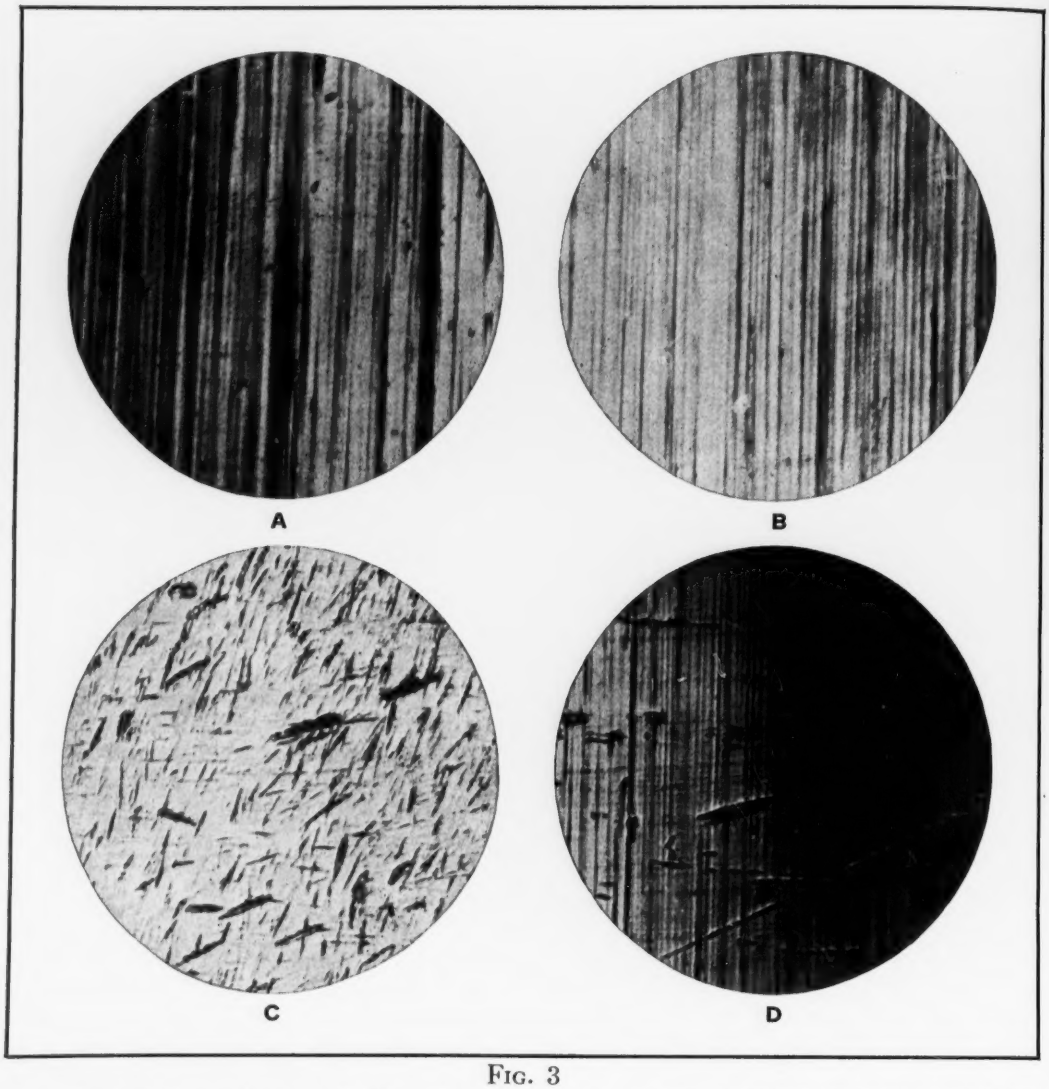


FIG. 3

A. Typical Example of a Working Surface × 100. (A Good Job of Grinding, with No Defects Visible to the Naked Eye; Ground with an 80-Grit Wheel)
B. A Working Surface Produced with a 500-Grit Wheel × 100
C. Lapped Surface × 100
D. Appearance of Working Surface after Lapping and Subsequent Grinding with 500-Grit Wheel × 100

in the highest price class, in a fit of discontent with his company's product, inserted an electromagnet in the oil stream while a standard engine was undergoing its dynamometer test. The result of this simple little test was so startling that this concern almost ceased manufacturing until means could be found to solve the problem which was thus so suddenly thrown up to them. The electromagnet had drawn a considerable quantity of ferrous particles from the oil stream, and this was proof positive that the initial wear on all contacting members was astonishingly high. The remedy was obviously a better quality of finish than any which had hitherto been considered acceptable.

It was realized that a lapping compound composed of particles of iron, steel, and bronze was a dangerous element to introduce into any piece of high-class, high-speed machinery.

A world-famous maker of Diesel engines, of

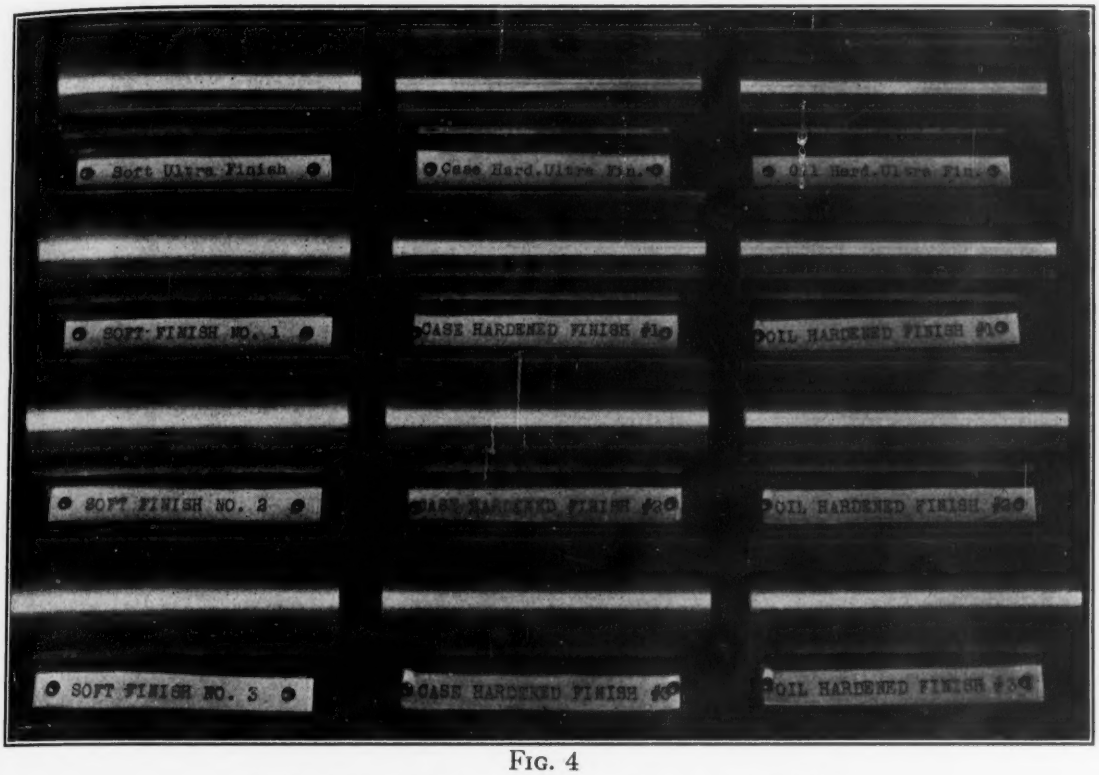


FIG. 4
Rack of Plugs Used as Reference Standards of Finish

both the marine- and the land-operating type, found that reduction in initial wear due to bettered methods of finishing enabled him to control his sizes so accurately that he reduced the running-in time of his engines to one-third of that previously found necessary, and at the same time increased the power-producing efficiency of his product by eight per cent.

A world-famous builder of locomotives made a test on a locomotive equipped with one cylinder which had been bored and another which had been bored and afterward ground. The locomotive was put on the road, and the cylinder heads were not removed for 14 months. Within two days of the inspection of this locomotive the process of finishing cylinders was changed to embody the improved method of finishing.

Much is heard about the appalling cost of rust or oxidation. Optimistic statisticians have even dared to put a figure on this wastage, which runs into billions of dollars. In the author's opinion it is not an exaggeration to say that this figure is at least equaled by the cost of largely avoidable wear. Hence there is what appears to be a sufficient and valid reason for the time given to the consideration of a subject, the economics of which involves such an immense sum of money.

Consider, for example, surfaces produced on cylindrical work, and discard for the moment the questions of accuracy as regards roundness and parallelism.

Figure 3A shows a representative plan view of an automobile wristpin ground to a finish which is generally considered good and acceptable by manufacturers who judge their product only by the naked eye. The finish-grinding

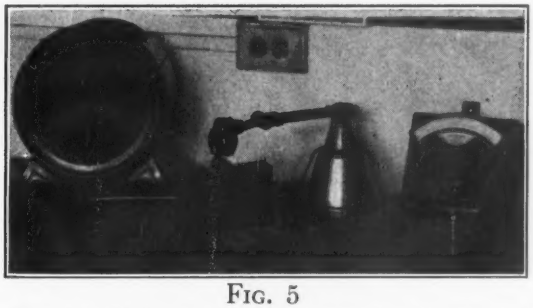


FIG. 5
Finish-Calibrating Instrument with Sound and Visual Recorders

operation was performed with an 80-grit grinding wheel.

Figure 3B shows the same piece reground with a 500-grit grinding wheel.

Figure 3C shows the same piece after being put through a lapping operation in which the

pin is held on a spider between abrasive disks that were mounted on vertical spindles.

Figure 3D shows the same piece after being

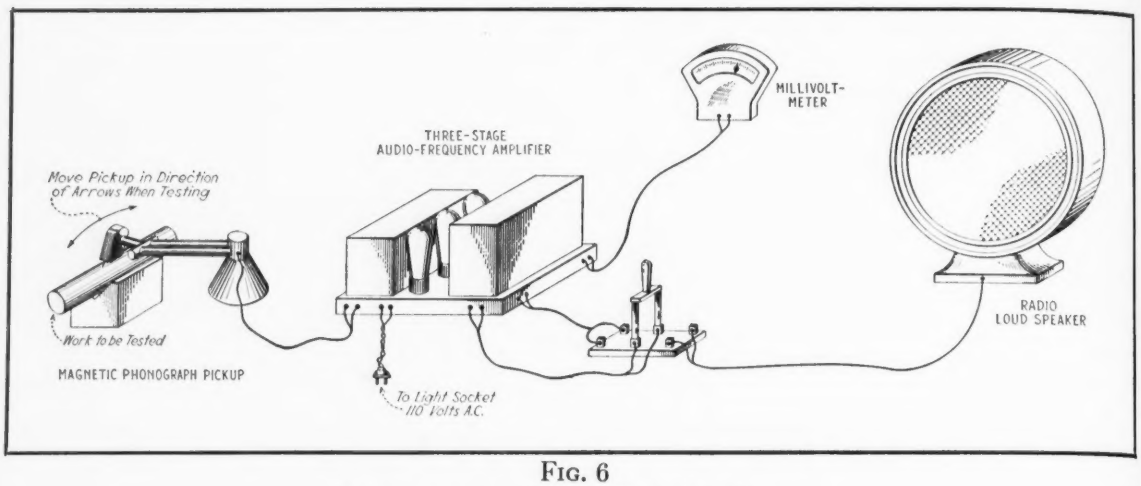

MILLIVOLT-METER
THREE-STAGE AUDIO-FREQUENCY AMPLIFIER
Move Pickup in Direction of Arrows When Testing
Work to be Tested
MAGNETIC PHONOGRAPH PICKUP
To Light Socket 110 Volts A.C.
RADIO LOUD SPEAKER

FIG. 6
Diagrammatic View of Finish Calibrator

again passed through the grinding machine following on the lapping operation. It will be noted that the grinding operation with the 500-grit grinding wheel has not been continued long enough to remove all the marks left by the laps.

The hitherto frequent renewal of automobile wristpins resulted in intensive study being given to this member, with the result that a very large percentage of pins built into new automobiles and those used as replacements are either ultra-finish-ground with a 500-grit grinding wheel or are lapped.

The surfaces on automobile crankshafts also have come in for much critical review, and at the instance of one of the leading automobile manufacturers, Dr. C. B. Sawyer of Cleveland has made some interesting cross-sections which emphasize the necessity for better methods of finishing. (See Appendix 1.)

The method of obtaining these interesting specimens was to immerse the samples in a copper-cyanide plating bath and give an initial coating. This is followed by immersion in an acid copper-plating bath where a heavy deposition of copper is made. The samples are then removed and cut, using a hacksaw, the cutting being so performed that the copper is forced toward the iron or steel.

These samples clearly illustrate the amount of irregularity which must be removed from the surface of an automobile crankshaft before the pin can establish a smooth and unobstructed path. (See Appendix 1.)

Experience indicates that there is no royal road or shortcut to a really high finish. Such finishes must necessarily be built up by successive stages.

Grinding wheels designed for producing the highest class of finish are incapable of an attractively high rate of metal removal. Hence, a practice has grown up whereby the bulk of the grinding allowance is removed with a wheel of from 60 to 80 grit. An intermediate finishing operation utilizing a wheel of 120 to 250 grit is interposed to top off the ridges caused by the grain depth of cut of the roughing wheel, and the final finish is imparted to the work with a wheel which may vary from 250 to 500 grit, the final result depending upon the standard of finish necessary for the satisfactory accomplishment of the work.

Attempts have been made to effect a shortcut, but these have all resulted in the building up of a false finish. In other words, the ridges are turned over into the hollows, and in actual service the results obtained are unsatisfactory.

2

Scheme for Establishing Standard Finishes in General Engineering Practice

Through the period of years in which mechanical processes have been developing, no satisfactory method of gaging finishes, other than with the eye, has been developed. This means, also, that there is no definite standard of comparison on either a world, a national, or even a local basis.

It is unfailingly true that in those countries where high standards of workmanship have been established engineers are more critical and de-

mand a higher finish, but this in turn is again, and has always been, a matter of mental comparison with no established basis on which to allocate a place to any one particular finish.

This matter has exercised some of the keenest minds in the industry and has been given very careful consideration by the American Standards Association.

In an attempt to obtain a solution to this problem in a practical workshop way, the author has adopted the following procedure:

A small rack, Figure 4, carrying one-inch diameter cylindrical plugs ground to the various progressive standards of finish, has been placed in each of the following departments for reference: engineering, grinding, inspection, standards, and laboratory.

The question at once arises as to how these standards are established, and this has been accomplished in the following way:

A finish-measuring device has been put into use, embodying an electromagnetic type sound detector or pickup as used in the better makes of electrically operated gramophones.

This instrument is connected up with a radio-amplifying unit and records minute vibrations caused by irregularities on the surface of the work to be inspected, reproducing them through a loud speaker.

The contact with the work is made with a chisel-edged sapphire, and a millivoltmeter records the amplitude of a current which is directly proportional to the vibration, and which passes across the grid of a supplementary radio tube.

Work which is relatively roughly ground produces a deep, harsh vibration in the loud speaker and a relatively large movement of the needle on the millivoltmeter scale. A finely ground piece of work produces a keen high note characteristic of minute vibration, and results in a relatively small swing of the millivoltmeter needle.

From the foregoing description, therefore, it will be seen that there is available both sound and visual measurement on a definite scale to supplement the microscope and the naked eye.

The instrument is extremely sensitive and particularly well suited to picking out that class of unsatisfactory work which, in the everyday phraseology of the mechanic, is "highly polished and deeply scratched."

Figure 4 shows the rack of finished samples, with three tiers each, containing soft, case-hardened, and oil-hardened steel samples.

Figure 5 shows the work-finish-testing instrument in contact with a piece to be tested, the loud speaker, and the millivoltmeter unit.

Figure 6 shows a diagrammatic view of the instrument.

Attempts to measure the finish obtained on ground work by means of instruments based on the ability of the work to reflect from a measured source of light have proved inadequate, inasmuch as it is too easily possible to obtain false readings from surfaces which, while

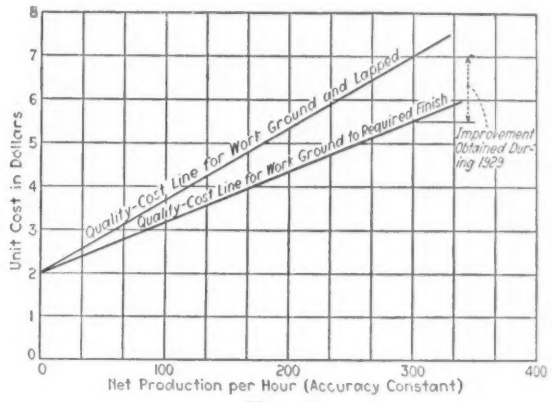


FIG. 7

Quality Cost Diagram Illustrating Reduced Cost of Improved Finishes Due to Improved Methods (Substitution of High-Production Grinding Operation in Place of Lapping and Polishing; Use of Heavier and Mechanically Improved Machines; Use of Greatly Improved Fine Grit Grinding Wheels; Improved Methods of Truing Grinding Wheels)

having the appearance of being highly polished, nevertheless contain comparatively deep furrows or scratches.

3

Relative Costs of Present-Day Standards of Finish

It being accepted that there is no available shortcut to high finish, it logically follows that the higher the finish the higher the cost on any given piece of work. However, much has been done in an endeavor to improve the standard, and the diagram in Figure 7 serves in a general way to indicate what has been accomplished during the last year or 18 months.

Case-hardened finish No. 3, which is equivalent to what is now generally known to the trade as a commercial finish, is accomplished on either the centerless or center-type cylindrical grinding machines, by rough- and finish-grinding the work with the same wheel, dressing the grinding wheel openly for the roughing operation and closely for the finishing operation.

Finish No. 2 is obtained in an identical way, but calls for the expenditure of from 15 to 20 per cent more time in the finish-grinding operation only.

Finish No. 1 is a refinement of finish No. 2 and calls for an additional grinding operation with a wheel of approximately 250 grit. This finish doubles the time required for the pre-

vious finishing operation, but does not in any way affect the time required for the rough-grinding operation.

The ultra-fine finish represented by the samples in the top row of the case calls for still another grinding operation, utilizing a machine designed and closely adjusted for this work. This finish is obtained by using a wheel of approximately 400 grit.

To state the matter in another way, finish No. 3 calls for two grinding operations with the same wheel. Finish No. 2 calls for two grinding operations, also with the same wheel. Finish No. 1 calls for three grinding operations, using two different wheels. The ultra-fine finish calls for four grinding operations involving the use of three different wheels. All the finish-grinding operations occupy about the same length of time and the cost of production is in proportion to the finish produced.

This is illustrated graphically by Figure 8.

Section B

1

Accuracy Considered as a Commercially Attractive Factor in Works Management

The relationship between quality and finish, as discussed in the foregoing section of the paper, and accuracy, considered as a commercially attractive factor from the point of view of the works management, may at first appear to be somewhat obscure.

However, experience indicates that the two subjects are very closely related by that relatively indeterminate factor known as initial wear. Until one is in a position to commercially produce work with practically no initial wear, it might justly be said that he is being deceived in the belief that work is being held within the specified limits of accuracy stated on the drawing.

The effects of this knowledge of the existence of high initial wear can be seen on every hand:

(*a*). Designers frequently tighten up their limits in the hope that when the initial wear has taken place they will still have mechanisms which operate without shake or without losing gas, air, or oil pressure.

(*b*). Designers frequently call for extremely expensive hand-lapping operations, knowing that this, being a slow process, offers maximum insurance against the assembly of parts which would otherwise retain possibilities of high initial wear.

(*c*). Makers of twist drills and plug gages insure that their products have a maximum useful life before the fuzz is worn off them and they are reduced to the low limit.

(*d*). Engine builders make their pistons larger in diameter in relation to the bore to insure that, when the engine comes off the dynamometer test, it will not have too much piston slap.

(*e*). The preloading of anti-friction bearings is another effort in this direction.

(*f*). Builders of high-class machinery erect, dismantle, inspect, reerect, run, dismantle, inspect, reerect, and run again to check up the results of initial wear known as the bedding-in process on their shafts and bearings.

In other words, it might truthfully be said that the test run of any piece of high-class machinery is a species of teething period during which its whole future lies in the balance.

That the commercial hazards of this process are to some extent recognized is evidenced by the rapid increase in the use of high-class honing equipment.

A high-class company has built up an attractive and economically sound business in lapping machines. Another company has put on the market especially equipped grinding machines, the sole function of which is to produce an ultra-fine finish on the work. All of which is proof conclusive that accuracy of product in which measurements are taken between plane surfaces and not over rough ridges of material is recognized by the discriminating engineer as a commercial necessity.

The practice, however, is by no means general, and, so far, has been restricted to relatively few of the many thousands of manufacturers producing what they honestly believe to be a quality product.

2

The Cost of Accuracy in Ground Work

One of the factors most closely affecting the manufacturing success of any modern organization is the intelligent use of the limit system, for in the specifying of close or wide limits the engineering department either can make or break the successful operation of any plant.

It is obviously most sound for the designer to specify the widest possible limits of accuracy consistent with the satisfactory functioning of the piece or mechanism under consideration.

There is evidence, however, that the question of initial wear does not always receive the consideration to which its importance entitles it, and it is becoming increasingly necessary for designers also to specify the class of finish on the bearings and sliding surfaces which operate under load.

The absence of a definite standard of finish has been a great obstacle, but it is hoped and anticipated that research work will shortly clear away this barrier.

Unfortunately, the subjects of finish and ac-

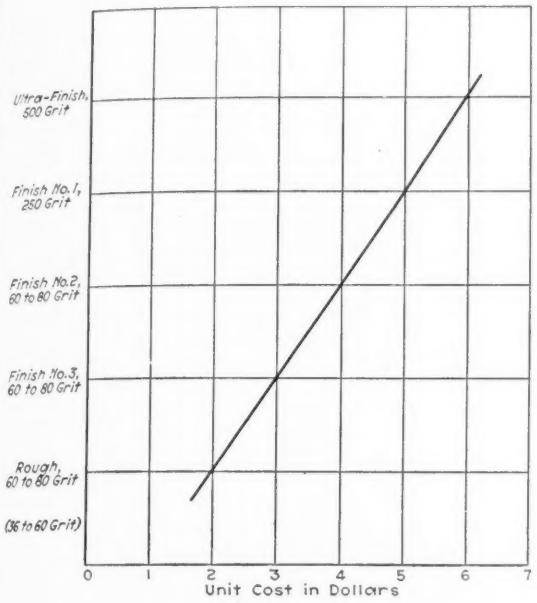

Ultra-Finish, 500 Grit
Finish No.1, 250 Grit
Finish No.2, 60 to 80 Grit
Finish No.3, 60 to 80 Grit
Rough, 60 to 80 Grit
(36 to 60 Grit)
0 1 2 3 4 5 6 7
Unit Cost in Dollars

FIG. 8

Quality Cost Diagram Indicating Progressively Increasing Cost of Various Grades of Finish

curacy within closely specified limits have been somewhat confused in the minds of many designers, and this has led to the belief in many quarters that because, say, a locomotive is built up of parts with wide limits of accuracy as compared with, say, a printing machine or a machine tool, the finishes on locomotive work can be relatively rough.

No greater fallacy exists, and although it is readily admitted that wide clearances are necessary to enable the motion gear of a locomotive to accommodate itself to a non-precision roadbed, the effects of high initial wear, due to lack of finish, are so costly and serious that it might be said that the bearings and wearing surfaces of a modern locomotive, while operating with greater clearances, at the same time demand on the score of economics a higher degree of finish than almost any other piece of mechanism.

Where the load as measured in pounds per square inch is intensive, initial wear can easily develop into permanent and continuous wear if the mechanism is not started out right in the first place.

In these days when a variance of sizing within 0.0002 in. may mean the difference between automatic assembly and hand selection, and this in turn may mean the difference between success and failure to make a profit and, therefore, for the firm to remain in business, it logically follows that the problem of accuracy and automatic sizing control has been put up to the machine-tool manufacturers in a very intensive way.

Conclusion

The conclusions which the author wishes to draw from the foregoing notes, data, and records of experiments are the following:

1. It is desirable that our efforts to work to close limits of accuracy be strengthened and improved by taking measurements across basically flat surfaces rather than across surfaces which have a relatively high factor of initial wear.

2. To enable this to be done, standards of finish should be established and these standards accepted in at least a national way.

3. The author submits for consideration a means whereby finishes can be calibrated and easy and accurate duplication of results be obtained.

4. A practical scheme applicable to most organizations carrying on engineering work is discussed and provides a basis on which refinement and special applications can be worked out.

5. A general guide to the requirements as regards the number of machine-shop operations to secure the different qualities of finish is discussed and submitted as representing the best available practice of today.

6. An endeavor has been made to show that there is at present no available shortcut to high-quality work with a low factor of initial wear.

7. The various means whereby surfaces with low initial wear can be obtained are indicated.

8. Finally, the author has shown that standardization of finishes can be attained at low cost and with practically no disruption of present methods; also, that limits of accuracy which control length of useful life are interlocked with the obtaining of a better quality and standardized finish.

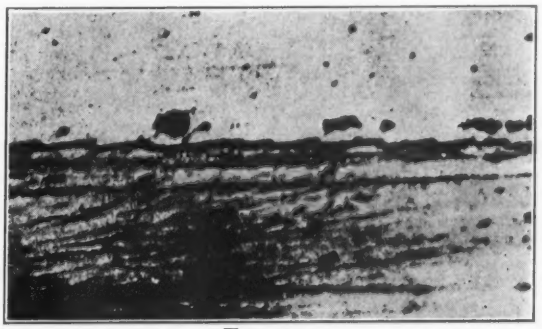


FIG. 9

Magnification Showing Slip Bands as True, though Minute, Steps

Appendix 1

Microscopical Examination of Cross-Section of Surfaces

by

Dr. C. B. Sawyer[3]

In the recording of the shape of design of objects in general it has been found most practical to take a series of cross-sections of the object on different planes through it. The number of such cross-sections necessary is determined by the irregularity of the object and the detail required. Such cross-sections may be made by a draftsman and filed away as blueprints.

When it is desired to obtain a similar record of a surface filled with very fine scratches or surface irregularities, it is necessary, first, mechanically to section such surface and, subsequently, to magnify and photograph its cross-section. Where ground surfaces are concerned, two or three sections are generally adequate to give a very fair idea of the dimensions and nature of irregularities existing thereon. For many purposes a single cross-sectional photomicrograph is adequate. A method for obtaining photomicrographs at magnification up to 1000 diameters of cross-sections of surfaces produced by grinding, honing, polishing, and the like is here described.

So far as is known to the writer, the method was first employed by the famous metallurgist, Walter Rosenhain, in his study of the dimensions of slip planes produced on polished metallic surfaces during deformation of the metal. For a general description of the method it would be difficult to find better words than those of Rosenhain himself,[4] as follows:

> "Still more conclusive, . . . is the demonstration of the nature of slip bands which has been obtained by the author by means of actual cross-sections of a surface on which slip bands had been developed. The difficulty in obtaining such a cross-section lay not alone in the minuteness of the surface features looked for, but also in the fact that, when a specimen is cut and polished, the edges of the surface are always more or less damaged and rounded off. Sharp images at high magnifications, therefore, could not be obtained by simply cutting a previously polished and strained specimen through at right angles to the original surface and then polishing the cross-section thus obtained. The author overcame this difficulty by first coating the surface on which slip bands had been formed with a thick layer of electrodeposited copper. When subsequently a section was cut through the compound mass—in this case of iron and copper—the boundary on the section, between copper and iron, gave the exact outline of the section of the original surface. When observed at a high magnification, such a section shows the slip bands as true, though minute, steps. The appearance, under a magnification of 1200 diameters, is shown in Figure 106. [See Figure 9 which is Figure 106 of the Rosenhain work.] It is of interest to note that the approximate depth of the minute slip-band steps seen in Figure 106 is $^1/_{50,000}$ of an inch, which is about the length of a wave of sodium (yellow) light."

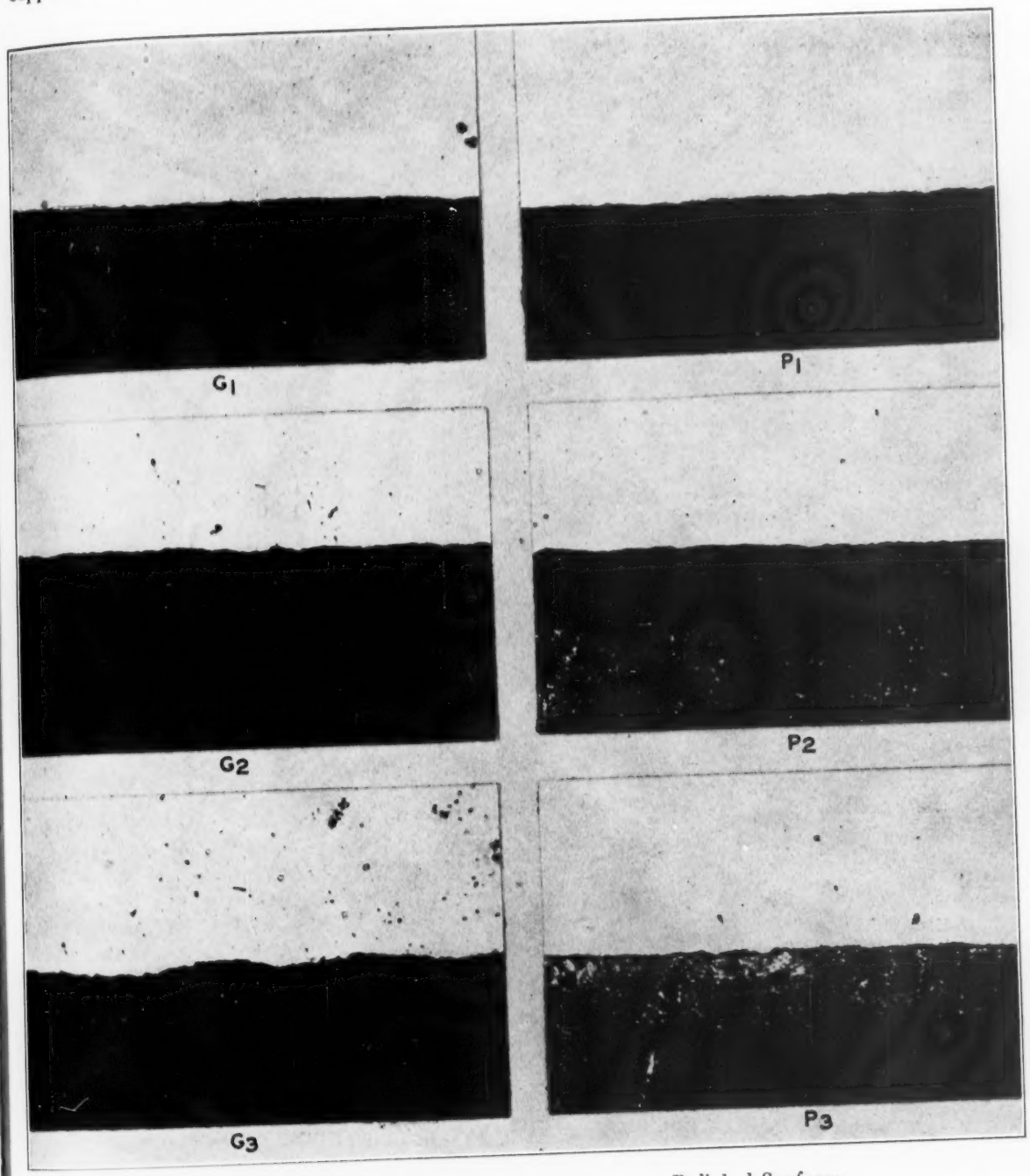
For the practical examination of iron or steel surfaces produced by grinding, it is first necessary to obtain a small sample of such surface, measuring perhaps an inch square, and as thick as general conditions may require. Such sample must have been preserved from rusting, corrosion, etc., after grinding. Before copper plating can be commenced, the surface of the sample must be freed from every trace of dirt and grease, without, however, damaging the surface. Cast-iron cylinders which have been subject to oil lubricants or preservatives present the most difficult cleansing problem, for the oil enters the graphitic pores and is very difficult to wash out. Long soaking in petroleum ether or pure ethyl ether is effective, or the sample may be placed beneath a reflux condenser so that freshly distilled clean ether is constantly dropping on its surface. It may be necessary to continue such treatment for 24 hours. Even when so cleaned the surface may still be covered with a very thin film of oil, and is best dipped in a hot (not boiling) dilute solution of sodium carbonate or sodium hydroxide. Such sample is then transferred quickly to distilled water before the caustic solution can evaporate. After rinsing in distilled water the sample is ready for copper plating. Non-porous materials, such as steel, are much more easily cleaned.

The copper plating is carried out with two baths. Were a steel sample to be dipped at once into the ordinary acid plating bath, "plating by contact" would ensue, and a non-adherent coating of copper would result, with corresponding solution of the steel sample and blurring of the minute outlines of scratches, etc. Consequently, it is necessary to start the plating operation in a cyanide bath in which "plating by contact" will not take place. Unfortunately, it does not seem possible to obtain, with

[3] President, The Brush Laboratories Company, Cleveland, Ohio.

[4] *Introduction to Physical Metallurgy*, Rosenhain, 1914, p. 245.

a cyanide bath, a sufficiently thick coating of copper to serve the whole purpose. Therefore, solving cuprous cyanide in potassium cyanide to form about a five per cent solution, with the



Ground Surfaces *Polished Surfaces*

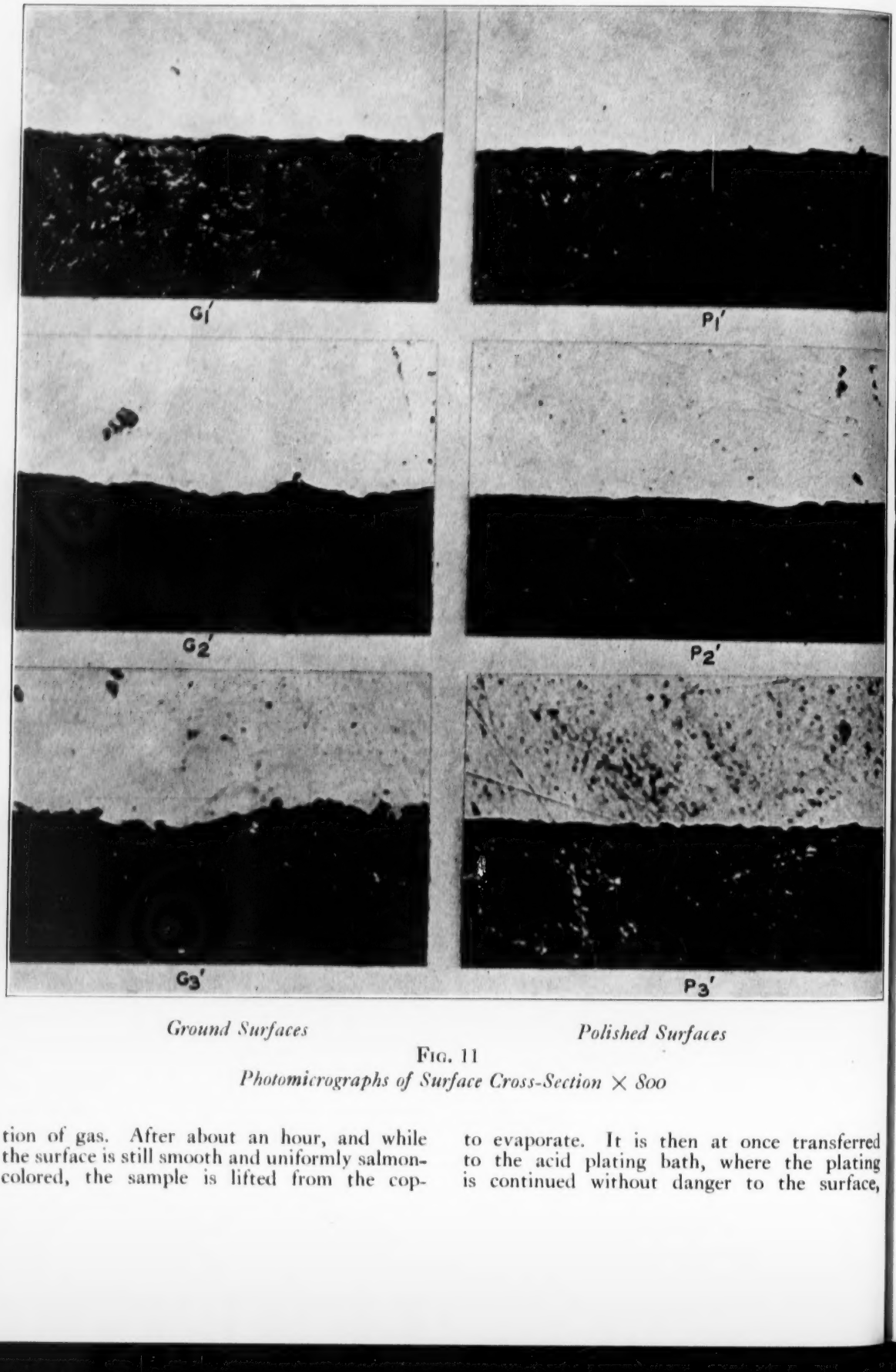
FIG. 10

Photomicrographs of Surface Cross-Section × *200*

the cyanide plating must be followed by plating in the ordinary acid bath.

A suitable cyanide bath is obtained by dis- addition of about one-half of one per cent of sodium carbonate. Plating is carried out at a temperature of about 50 C, and with the

usual copper anode. The current density should be sufficient to produce a considerable evolution of gas. After about an hour, and while the surface is still smooth and uniformly salmon-colored, the sample is lifted from the copper cyanide and quickly washed in distilled water before the adhering solution has time to evaporate. It is then at once transferred to the acid plating bath, where the plating is continued without danger to the surface,



Ground Surfaces *Polished Surfaces*

FIG. 11

Photomicrographs of Surface Cross-Section × 800

because of the protective coating of copper laid down in the cyanide bath. A suitable composition for the acid bath is that used for copper coulombmeters, as follows: 1000 grams of water, 150 grams copper sulphate, 50 grams concentrated sulphuric acid, and 50 grams alcohol.

Plating takes place at room temperature, and is greatly expedited if the solution is strongly and continuously stirred, as by an electric motor. Deposition continues until the thickness of copper overlaying the surface to be examined is about 1/8 in. The time required varies from two days to a week, depending on the degree of stirring, which in turn controls the maximum current density at which adherent copper is deposited.

When the copper coating is of adequate thickness, the sample is removed, washed, and cut with a hacksaw along the plane desired. As the copper coating is not extremely adherent, it is best to have the saw teeth move from copper toward steel, thus avoiding as much as is possible any tendency to tear the copper away from the surface. After so cutting, the specimen is polished by the usual metallographic methods. As copper is very much softer than steel, there will result at best an inequality in the level of the copper surface and the steel surface, but this can be reduced by the use of emery paper as much as possible in the polishing operations.

Results obtainable with this method are illustrated by the accompanying photomicrographs made several years ago in studying the bearing surfaces on two crankshafts. The surfaces on the one crankshaft were finished by grinding; on the other by "polishing." Three samples from the bearing surfaces of each crankshaft were copper-plated and prepared as described.

Each group of three samples was photographed at a magnification of 200 diameters (Figure 10) and at a magnification of 800 diameters (Figure 11). The first group of photomicrographs are at 200 diameters. They comprise samples G1, G2, and G3 from the ground surfaces and P1, P2, and P3 from the polished surfaces. The second group at 800 diameters is similarly designated, G1′, G2′, and G3′ and P1′, P2′, and P3′.

In these cross-sectional photomicrographs the copper plating appears white, while the steel is black, due to etching in the usual nital to accentuate the contrast between the steel and the copper.

As before stated, there is a slight difference in level between copper and steel, which results in a blurred appearance of the steel structure, as the camera was necessarily focused on the copper. Nevertheless, all boundaries, even at 800 diameters, are sharply defined and give the exact shape of scratches as little as 0.00001 in. in depth.

In the case of these crankshafts it is evident that the polishing operation produced a more uniform product. The ground surfaces varied from bearing to bearing, probably with the truing of the wheel. Sample G3 was probably produced with a freshly trued wheel, which became somewhat glazed by the time it reached G1. Such a partially glazed or filled wheel polishes somewhat as it grinds, and the surface produced by it approaches a polished surface.

Appendix 2

Circuit Diagram of Finish Comparator

The diagram (Figure 12) represents the circuit used when making the visual and sound records.

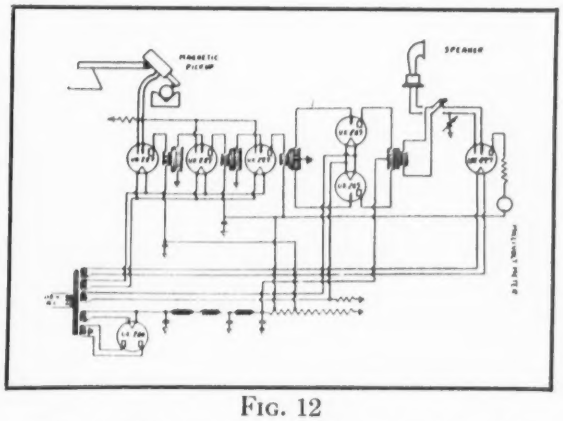


FIG. 12

Circuit Used in Making Visual and Sound Records

A further refinement and a permanent record can be obtained by connecting an oscillograph instrument to this circuit.

Appendix 3

Oscillograph Records

Figure 13 shows oscillograph records made from a set of plugs similar to those shown in Figure 4. It was ultimately found advisable to include a set of plugs of cast iron in addition to the soft-steel, case-hardened steel, and oil-hardened steel plugs. These records clearly show the varying equality of finish in each material, and are of great value in those cases where it is considered desirable for a record of the quality of surface to be kept for future reference.

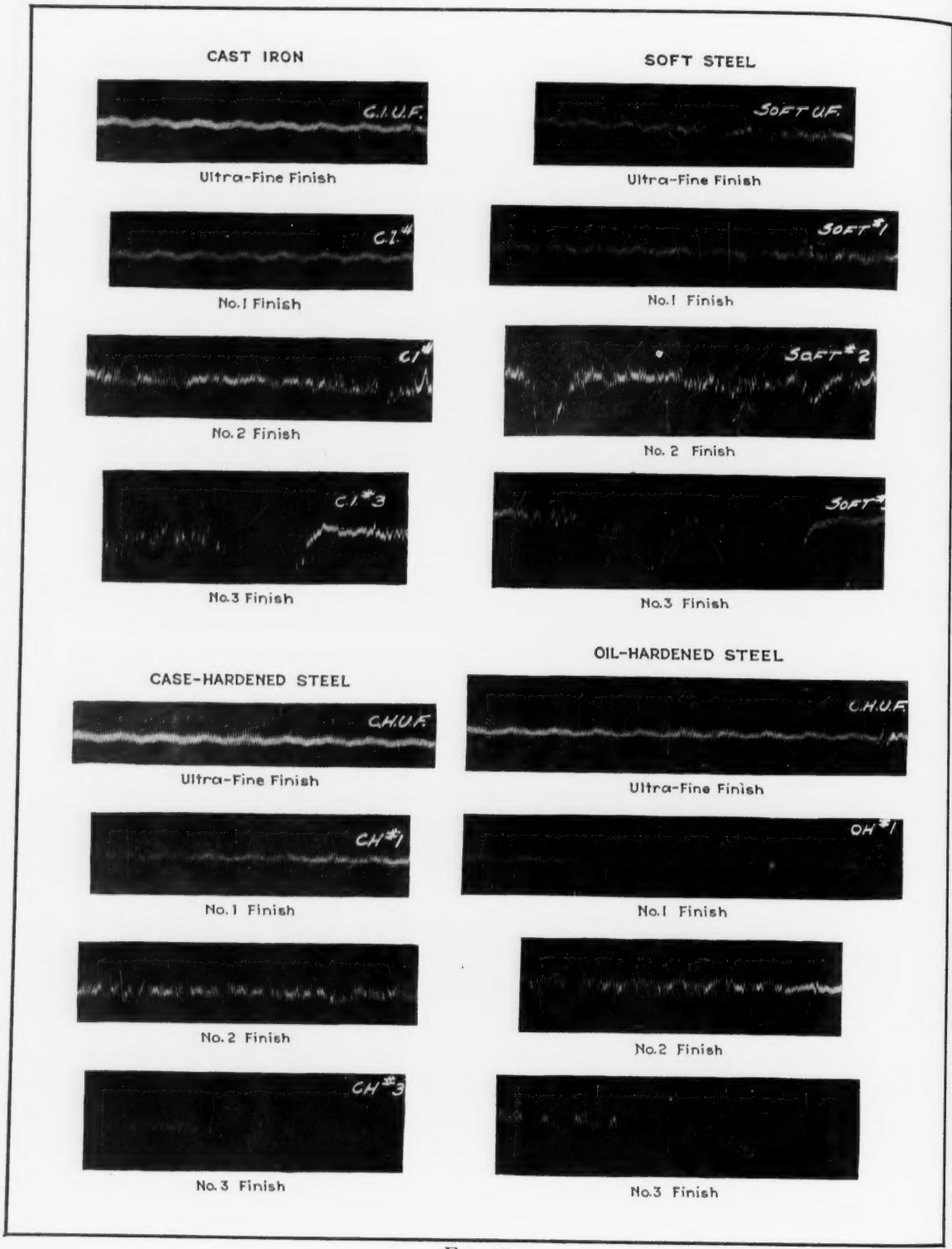


FIG. 13

Oscillograph Records
from a Set of Plugs Similar to Those Shown in Fig. 4

Discussion

CHRISTOPHER H. BIERBAUM:[5] This paper is certainly timely and interesting, since further improvements of machine tools and their operation necessitates a higher grinding practice, especially so for bearing surfaces.

The photographic method for determining the roughness of a ground surface is not at all conclusive; it leads to many inaccuracies and incongruities, for the reason that it is subject to so many variations and interdependent factors. Of these the illumination is of primary importance; its intensity, direction, and degree of diffusion all have a very material bearing upon the final result. The inherent degree of contrast in the photographic plate and also that of the printing paper are very distinct factors, as well as the personal equation and chemicals used in their developing; all affect the final result in a marked degree. The procedure for determining the smoothness of ground surfaces presented in this paper overcomes all of the photographic difficulties and seems altogether practical and accurate.

In the present grinding of metallographic specimens a high degree of grinding perfection has been attained. This work has clearly shown that for economy an increasing degree of fineness of abrasive is necessary for successive grindings and that for the greatest accuracy of finish a final material must be used that is both sharp and cutting. This work also shows that the directions of grinding should be continuously changed; this, however, is not readily possible in the grinding of cylindrical surfaces. The value of more accurate and perfect grinding cannot be overestimated; it reduces the time for the running-in of bearings; it reduces the aggregate amount of wearing down that is necessary during such running-in, thereby very materially reducing the liability of introducing inaccuracies in the bearing surfaces during the period of running-in.

Many manufacturers have found that the highest degree of accuracy of finish in their bearings is an economic investment. This is especially true for bearing alloys that cannot be finished as easily as steel by grinding, and for that reason they have resorted to finishing with a diamond cutter, taking a depth of final cut of 0.001 in. or less, at a very high speed, and thereby leaving all of the bearing crystals upon the surface in an undisturbed condition,[6] leaving these hardest crystals flush with the finished surfaces; that is, in a state that most nearly approaches a run-in surface. By such procedure they have found that bearings can be produced which require very little or no preliminary running-in. This, together with the further improvement of the grinding of steel journals, should have a very marked effect upon the success of sliding-surface bearings.

JOHN GAILLARD:[7] The paper makes it clear that a high quality of surface finish should not be confined to fits requiring small allowances and close tolerances, but that it should also be applied to less exacting fits in cases where strong initial wear of the mating parts is to be avoided. This view accentuates the fundamental difference, too often disregarded, between the concepts "quality of fit" and "quality of surface." The quality of a fit depends on the ratio between the maximum and minimum permissible clearance or interference, or in other words, on the permissible variation in looseness or tightness. This again depends directly on the sum of the tolerances on the mating parts. The quality of a surface depends among other things on the maximum variation of its points from a true cylindrical plane. One could say that for a specific quality of finish all points of the surface concerned must lie within a definite "finish tolerance." For a surface of high quality this "finish tolerance" is of a smaller order of magnitude than the tolerances on the size of the parts. Dr. Sawyer's micrographs with a magnification of 800 times illustrate this. Although, in principle, quality of fit and quality of surface are different concepts, there is a practical relationship between the two. Close tolerances naturally demand a good quality of finish. The opposite is not necessarily true, however. Fits with large clearances and tolerances may be established without the parts receiving a high-grade finish. However, as the author points out and illustrates by practical examples, it often will be desirable, if not necessary, to give the parts a high-grade finish anyway in order to prevent rapid, initial wear.

The paper shows that the art of producing good fits is progressing consistently along lines leading to greater refinement. Without being able to forego high speed of output, mass production has arrived at an accuracy of sizing parts and at a quality of surface finish that would have been impracticable in the workshop a few years ago even for serial production. The indications are, therefore, that the time is near when specification of a definite quality of finish by the designer will be regarded as just as necessary as the specification of tolerances on the sizes of the parts. It will not be sufficient to state, for example, that a part should be ground, but it also will be necessary to mention by class the quality of surface desired, and this again raises the problem of classi-

[5] Vice-President and Consulting Engineer, Lumen Bearing Company, Buffalo, N. Y.

[6] A.S.M.E. Trans., Dec., 1919, pp. 799–802.

[7] Mechanical Engineer, American Standards Association.

fying surface finishes. This requirement is analogous with the necessity of standardizing classes of fit based on definite values of allowances and tolerances. So long as the nature of a fit is merely expressed by such terms as "snug," "wringing," "push," or "tight," no fit can be definitely specified. These terms have different meanings in different shops, and even with different individuals. If they have the same meaning, their interpretation is still dependent on the personal factor. A fit defined as a "wringing" fit by a husky fellow may feel like a "tight" fit to a man with less manual "torque."

The first step taken to eliminate the human factor in determining the class of a fit was to use a "standard" plug and ring giving practically a "metal-to-metal" fit together. That is, a physical example of a fit was created which could be imitated (or at least approximated) or varied from in a definite direction, as the case might be. The author's first step toward standardizing the class of a surface has been a similar one. Sets of plugs finished with different qualities of surface were established to serve as visual guides. However, in addition to this, the author struck upon the very ingenious idea of translating the frequency of unevenness of a surface per unit of length into frequency of sound waves per unit of time—that is, into the pitch of tone. This method has the great advantages of being easily applicable and of giving an immediate answer to the question of what the quality of a surface is. The author must be congratulated on the simplicity and originality of this development. In addition to establishing a basis of measurement with consequent possibility of standard classification of surface finishes, it has the charm of containing a promise that in the future the surfaces of component parts may literally be tuned together for greater harmony in the assembled product.

As stated in the paper, the need for a basis of classification has been growing in recent years. Investigation of the nature of different surfaces was a basic requirement in trying to solve the problem. Different methods for doing this have been worked out. One of these, developed by Professor Berndt, of the Engineering Academy, Dresden, Germany, whom the writer visited this summer, may be of interest here. It complements Mr. Harrison's method in a remarkable manner and shows again how the existence of a problem may lead to its solution by independent experts at almost the same time. In the present case the solutions are different, but they show a similar basic feature.

Professor Berndt has developed a method of recording the minute irregularities of the profile of a finished surface. He lets a fine needle (so far he has used a gramophone needle) travel over the surface at such a slow rate of speed that the point follows all of its ups and downs. To do this, the part whose surface is being investigated is moved and the device carrying the needle is stationary. The needle is attached to a spring on which is mounted a small mirror. A beam of light is thrown on the mirror through a very fine slot and is reflected on a slowly moving film of sensitive paper. The beam thus traces a latent curve on this strip representing the magnified outline of the surface investigated. The strip is developed and oiled to become printable. The graphs thus obtained which were shown to the writer represented the outline of the surfaces investigated to the scale of either 400 to 1 or 1000 to 1.

One of Professor Berndt's students has used this method in the investigation of a large number of surfaces finished by different methods of machining; such as turning, grinding, lapping, broaching, and honing. Also, the surfaces of parts tapped with cut taps and with ground taps were investigated. The study formed part of a "doctor of engineering" dissertation, and no details are as yet available for publication. The writer hopes to be able to report about the details in the near future when they are released.

Professor Berndt said that the needle method had given very good results, but that with increasing precision in surface finishing a point sharper than that of a gramophone needle was now required. Before developing this method, he had used two others. One of these, invented by a British expert, consists in making gelatin casts of the finished surfaces. These are cut to very thin slices, which are viewed under the microscope. This method appeared to be unreliable, as the casts warped when and after being removed and therefore did not represent true negatives of the surfaces. The interesting method of making the outline of the surface visible in cross-section described in Dr. Sawyer's paper, appended to Mr. Harrison's, marks great progress in this respect. The other method applied by Professor Berndt consists in measuring the maximum angle at which the surface still gives a fairly sharp image of a series of geometrical figures placed in a comparator, the surface under investigation deflecting the rays of monochromatic light sent out by the figures. Past a certain angle the image becomes decidedly blurred. This method has been checked by Professor Berndt with the needle method, with satisfactory results. Of course, the reflection method does not give details of the surface as the needle method does. In this connection it is interesting to note that Mr. Harrison refers to the occurrence in practice of "highly polished and deeply scratched" work possessing rather

smooth surfaces located between pronounced ridges, which work gives a higher rating when subjected to the reflection test than it really merits from the viewpoint of quality of surface.

The practical solutions of the problem independently arrived at by Mr. Harrison and Professor Berndt are different and complementary. Mr. Harrison's method makes it possible to get an immediate but general answer regarding the quality of a surface. Practically, such answers will probably be quite satisfactory in the large majority of cases. The application of Professor Berndt's method requires considerably more time and effort, but it gives a detailed and permanent record of the surface investigated. There will be cases in which one of the two methods should preferably be applied, and other cases where both should be used for the sake of completeness. Viewing in general the art of finishing surfaces and classifying their quality, both developments constitute a genuine contribution to the art by laying a basis for the replacement of judgment by measurement and the consequent possibility of standardizing the practice.

The writer has followed the developments in this field with the deepest interest, both as a mechanical engineer and as a staff member of the American Standards Association. When the time is ripe in the opinion of the experts in this field to discuss the matter with a view to the possibility of establishing a national standard method of classifying surface finishes, ASA will be very glad to lend its assistance in organizing the work. For the present the writer wishes to congratulate Mr. Harrison on the great value to industry of his findings and on the exceedingly lucid manner in which his presentation has been made.

SANFORD A. MOSS:[8] Mr. Harrison properly distinguishes between truth of a surface and finish of a surface. A surface may have a low grade of finish and yet the high spots may be on a surface which is flat or true within a few tenths of a thousandth. On the other hand, the surface may have a high-grade finish according to Mr. Harrison's standards, and yet it may be out of round or out of truth by 0.0005 in. or even 0.001 in. Is it not possible that some of the benefits due to wearing-in are due to correction of errors of truth rather than errors of finish? In case of perfect film lubrication, there is supposed to be a layer of oil separating the surfaces. If the surfaces are perfectly true, it would seem that the finish is not a major item. There is, of course, another class of lubrication where there is not a perfect film, but merely a sliding of two greasy surfaces. For this sort of thing the finish is no doubt highly important. Of course, a first step toward finding out the cases where the finish is the major matter and the cases where truth rather than finish is the major matter, is the standardization of quality of finish, just as Mr. Harrison proposes. It is to be expected, therefore, that the pioneer work which Mr. Harrison has done will be followed up to a conclusion.

[8] Mechanical Engineer, Thomson Research Laboratory, General Electric Company, West Lynn, Mass.

G. A. BOUVIER:[9] The electrical method described in the paper, of calibrating the character of a surface, is not only new and novel, but apparently promises greater opportunity for general use in industry than methods suggested heretofore. While the author has stated that his work can only be regarded as preliminary, it is hoped that other investigators will take part in further research work. No doubt Mr. Harrison himself, if he has not already done so, will discover further advantages of the method.

A number of limiting factors have occurred to the writer which affect the method and which should be evaluated for a complete understanding of the subject.

Fundamentally, the proposed scheme consists of the generation of electrical energy by the movement of a phonograph needle over the surface whose character we are interested in. The phonograph needle, in this instance, is attached to an ordinary magnetic pick-up as used on phonograph records; in other words, a type of electrical generator. The movement of the needle over a hill-and-valley surface at a definite rate will, of course, result in the output of an electric current having a certain frequency relation to the number of hills and valleys over which the needle moves. Obviously, the power or energy generated will also have a definite relation to the character of the surface, because the hills and valleys not only differ in spacing but also in depth. The frequency would show up on the loud speaker as a complicated pitch or tone, and the energy as volume. Obviously, such a complex audible sound made up of overtone and discords can give to the investigator only a very rough indication of the real character of the surface. The writer would like to learn the results of further investigations of this method made with a recording oscillograph. This would supplement, in greater detail, the millivoltmeter readings which average the electrical output and hence give an index of the average roughness.

In ordinary ground work, as illustrated in Figure 2, the scratches all run in the same direction. These scratches constitute the major surface imperfections, so that drawing the needle point at right angles to them, as done by Mr. Harrison, would give the maximum

[9] Development Engineer, Hawthorne Works, Western Electric Co.

energy output and the best index of surface roughness. On certain types of surfaces, however, such as the lapped surface shown in Figure 5, the surface scratches possess no definite direction. On a surface of this type it appears that millivoltmeter readings should be taken for needle movements in two directions at right angles to each other, and the results averaged.

It is apparent that such factors as the type of point, the weight on it, and the electrical constant of the amplifier will affect the results obtained. These factors must be standardized to make the device of general utility to the industry. The development of more knowledge concerning the limitations of this new method and the establishment of standards certainly will result in its ordinary and regular use in the shop for controlling the character of the finish on a definite standard basis instead of by the visual determinations now attempted. This method is especially suitable for measuring finishes so fine that methods employing the reflection of light cannot be applied. The writer hopes that Mr. Harrison will continue without interruption the development of this idea.

LUTHER D. BURLINGAME:[10] The presentation of this valuable paper emphasizes the fact that there has in recent years been a transference of skill from the workman to the machine so that precision work and that having a high degree of finish and accuracy, emphasized by Mr. Harrison, can be produced commercially. In the early days of grinding, the producing of such results depended on the skill of the workman.

In investigating historical matters relative to the origin and early use of grinding processes, it has come to attention that in those days grinding was done on an engine lathe with a grinding wheel mounted on the carriage, and personal skill was required in order to produce the desired grade of work; one of the workmen being so expert in this that he commanded a wage which placed him with the proprietors of the business, so that he came to the shop, as did they, in a tall silk hat. Skill in those days depended on knowing where to stand on the floor and where to tap the machine in order to secure satisfactory results.

This led Joseph R. Brown to invent the universal grinding machine, which he brought out in 1875 and which was first shown at the Centennial Exposition in 1876.

During the period since that time continued improvements have been made in the grinding art and in the machine connected therewith, so that today results can be obtained such as those pointed out by Mr. Harrison in his comprehensive paper.

[10] Legal Technician, Brown & Sharpe Mfg. Co., Providence, R. I.

Authors' Closure

DR. C. B. SAWYER: Mr. Gaillard's remarks concerning the appearance of a technique for studying production results at such time as the demand for better control arises in the producing industry itself seems well illustrated in the present case. The work on microscopical examination of cross-section of surfaces here described was completed some five or six years ago, and has lain dormant from that time forward, until brought to the attention of Mr. Harrison. It now appears that the demand for better production control of surfaces has resulted not only in the appearance of the two methods described in this paper, but also of Professor Berndt's, and doubtless of others to be heard from later.

With reference to the time required for copper-plating surfaces, two days is probably the minimum so far attained, but new methods for copper plating are accelerating the rate of deposit, and doubtless such time can be further very considerably reduced. Probably the time required for copper plating and examination of the surfaces can ultimately be reduced to an amount at least comparable with that required for an ordinary metallographic examination of steel structure.

From the photomicrographs shown, it is apparent that the method of copper plating surfaces gives details in contours attainable by no other method so far suggested. It is, therefore, at once evident that the copper-plating method should be very useful in correlating or calibrating the indications obtained by other methods which may be much quicker.

Further, it is evident that with the lessening of time required for preparing copper-plated cross-sections, the method becomes more and more useful for routine control of machine-shop production. It approaches the type of control furnished by ordinary metallographic examinations. Such type of examination may be applied to specimens selected from a run of any specified number of units.

Mr. Harrison has asked me to make a few observations on the acoustic method described by him, and in this connection it is well to consider the characteristics of the human ear.

In the perception of quality of tone, the human ear is truly remarkable. It possesses the ability to resolve a complex tone into its various components, and for a true qualitative match of electrical impulses derived from ground surfaces of repetitive characteristics by Mr. Harrison's phonograph pick-up and amplifier, the ear is probably irreplaceable by any instrument such as an ammeter, or even recording oscillograph, because this latter requires time for the development of images. Unfortunately, on the

other hand, the human ear is not especially sensitive to changes in tone intensity. At fair volume proceeding from a radio speaker, the ear can, under most favorable conditions, detect a minimum of a ten per cent difference in intensity, but the attainment of this minimum requires instantaneous switching from one tone to another at least once a second, and preferably four or five times a second. Moreover, there should be a low level of extraneous noise. Such low level of sound would be difficult to obtain in an ordinary machine shop, and the requirement for quick comparison of tones predicates a more elaborate apparatus than that described by Mr. Harrison. Probably under most conditions of use with apparatus like Mr. Harrison's, the ear would do well to detect a 50 per cent difference in sound intensity, this arising in turn from like differences in the ground surfaces. In a sense, this is advantageous, as any real difference detected by the ear will certainly proceed from a very real difference in the surfaces.

With proper precautions, such as a soundproof room, two phonograph pick-ups adapted to be drawn at identical speeds over the samples under comparison, and mechanical motorized switching devices, Mr. Harrison's method could be refined to give very quick and accurate comparison of surfaces. However, for the great differences prevailing in ground surfaces at present, the method just as described by him is very useful, and it can be borne in mind that, when conditions warrant, refinements such as indicated can be worked out.

The question has been raised as to the effect of harmonics introduced by amplifier and speaker. In my opinion, the perfections lately incorporated in phonograph pick-ups, amplifiers, and loud speakers should eliminate cause for worry on this point when the application is limited to simultaneous comparison of samples.

For those further interested in the effect of sound on the human ear, reference can be made to *Speech and Hearing*, by Harvey Fletcher, Ph.D., published by D. Van Nostrand Company.

MR. HARRISON: The author readily agrees with Mr. Bierbaum regarding the limitations which apply to the photographic method of recording imperfections in machined surfaces.

He was particularly pleased to see the reference to the effect that, in the preparation of metallographic specimens, the material used for the final finishing operation must be both sharp and cutting. This is additional confirmation of the author's invariable claim that finish should never be obtained other than with a sharp and precise tool, as otherwise the surface produced has a false finish and is untrue either as a cylinder or a plane.

There are of course many applications where precision is not of prime importance, but in those cases where precision requirements are paramount, there can be no compromise; i. e., the final operation, either grinding or polishing, must be performed with a tool which is just as precise as the finest limit required on the work, and this tool must be held with maximum rigidity and guided with an accuracy which will permit the desired degree of tolerance to be maintained.

Mr. Bierbaum's remarks under the heading of artificially matured bearing surfaces also are of special interest, inasmuch as, in the author's experience, a considerable number of very accurate and high-finished spindles have been ruined in a short time by inserting them in bearings which have been scraped in such a way that the actual contact points between spindle and bearing have been the hard crystals in the bronze.

This has resulted in high unit pressure, disruption of the oil film, and all the troubles which go with excessive heating and carbonization of the lubricating oil.

The diamond boring tool seems to offer the solution, as it will perform the same function as a properly graded grinding wheel, and instead of exposing the hard crystals, will leave them flush with the surface where they properly belong and where they can exert their best influence in supporting the spindle.

Mr. Gaillard's remarks regarding the experimental work carried out by Professor Berndt

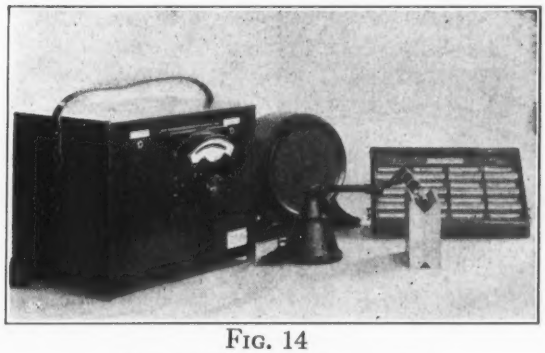


FIG. 14
New Calibration Instrument

are also extremely interesting, and it is a remarkable coincidence that Professor Berndt should be engaged in an endeavor to find a solution to this problem simultaneously with ourselves.

It has been the author's endeavor to devise an instrument capable of practical workshop application, the principle on which this instrument is designed being capable of expansion, to take care of the greater refinements which

are desirable and permissible in a laboratory investigation.

The main virtue which might be claimed for the author's scratch test is the ability of the instrument, both visually and orally, to detect and record the spurious finish; i. e., the one with high luster but serious mechanical imperfections.

It is the author's hope that the American Standards Association will continue to give practical expression to its interest in this subject to the point where national standards can be set up.

In reply to Mr. Moss's contribution to the discussion, the author would state that he considers it a major requirement that any piece of work should have all practical mechanical imperfections removed before there is any discussion with regard to its finish. The question of finish is raised in conjunction with durability of accuracy.

In other words, it has been repeatedly proved that extremely fine limits of accuracy, with their proportionately increased cost, are wasted on articles produced with a coarse finish, this being due to the high initial wear inseparable from a coarse finish.

The author readily agrees with Mr. Bouvier that the method which is put forward is not free from technical imperfections. However, as pointed out by Dr. Sawyer in his joint closure, the method of calibration has proved sufficiently accurate to enable a control to be set up which is generally commercially acceptable.

In line with Mr. Burlingame's comments, the development of the grinding wheel has been concurrent with that of the grinding machine. However, despite the high standard of attainment which has been reached by both elements, so far no definite standard of performance has been set up for either.

The author appreciates and acknowledges the value of the pioneer work accomplished by Mr. Burlingame's company.

The author gratefully acknowledges the encouragement contained in these discussions, and in reply to the hopes that have been expressed that experiments will be continued, advises that work on both the instrument itself and the technique of finish calibration has gone forward to the point where an instrument has been produced, as shown in the accompanying illustration, Figure 14.

The instrument shown at the left of this illustration is portable and durable, and it is anticipated that it shortly will be made commercially available to all concerns having an interest in this subject.

The Establishment of Standards for Machine Finishes[1]

by

R. C. Deale, *Management Engineer*
Stevenson, Jordan, and Harrison

A description of present conditions and an outline of a proposed system of specifying the various types of finishes

While there has been a very considerable change in drafting practice since the time when one man both designed a machine and supervised its construction, little or nothing has been done as to the specification of the quality of the machined surface on the drawing. It is believed that such specification of the quality of surface will produce manufacturing economies in all types of machine shops comparable to those that followed the introduction of tolerances.

When one man was both designer and machinist, little was necessary beyond a simple line layout giving the main dimensions of the machine or mechanism. The designer, being the machinist engaged in translating the drawing into metal, or at least being in intimate contact with that procedure, could work out the details of parts as necessary. When fits of one sort or another were called for, one part was made first, somewhere near the desired size, and the mating part fitted into it. Such methods produced machinery which operated satisfactorily, but were suitable only for equipment made in very small lots. Exceptionally skilled supervision was

[1] Reprinted from the October, 1931, issue of *Mechanical Engineering*.

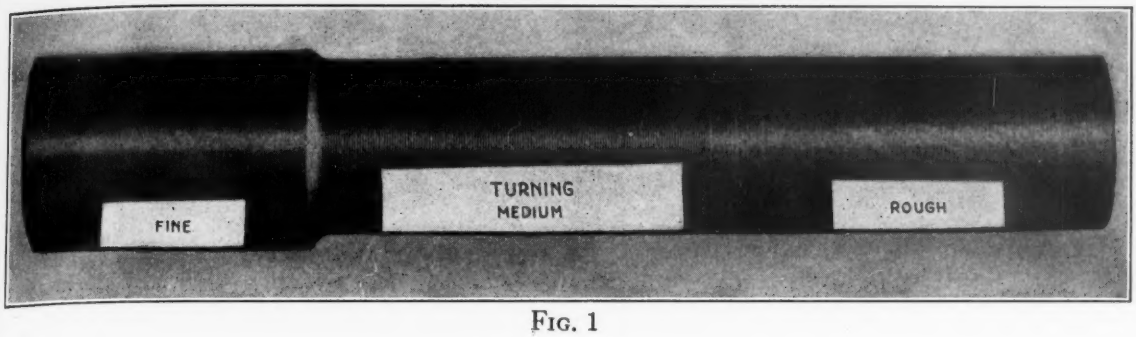


FIG. 1
Turning Finishes

required, as were also workmen capable of performing several or all of the operations.

As shops grew larger, it became necessary to make the drawings clearer, putting practically all the dimensions on them. Drawings of intricate machinery when so dimensioned are difficult to follow and require very close supervision of all machining operations, as a mechanic is very apt to make mistakes in following them. In addition, the allowances for various sorts of fits must be supplied by some one, whether foreman or machinist. It is not uncommon, where such drawings are furnished a shop, for the foreman to spend a considerable portion of his time in making detail sketches of the various parts.

As a result, the more progressive shops are making complete detail drawings of all parts of a mechanism, frequently with but a single part to a sheet.

A still later development, without which modern mass production would have been impossible, has been the addition of tolerances to each dimension, so that each piece may be machined completely without reference by the mechanic to any other part. When such tolerances are properly applied, the parts may be assembled into the completed mechanism with a minimum of fitting, though it may be necessary for these tolerances to be extremely small for interchangeable assembly. Modern machinery has made it possible to produce parts economically to almost any required degree of precision. The success of the American automotive industry is based entirely upon the use of parts

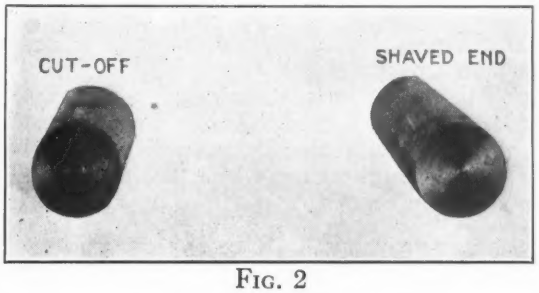


FIG. 2
Shaft-End Finishes

machined to close tolerances, which are shown clearly on the detail drawing, and then assembled with little or no fitting into a successfully operating machine.

While complete specification of the dimensions and material of a part is becoming more and more general, few plants have done anything in regard to the specification of machining finishes. As a result there is continual friction within the plant as to just the sort of surface required. This is particularly true in plants making a large

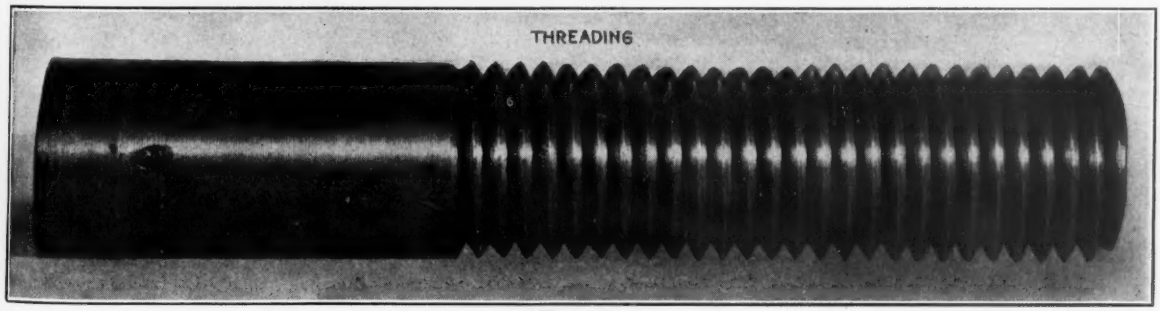


FIG. 3
Thread Cutting

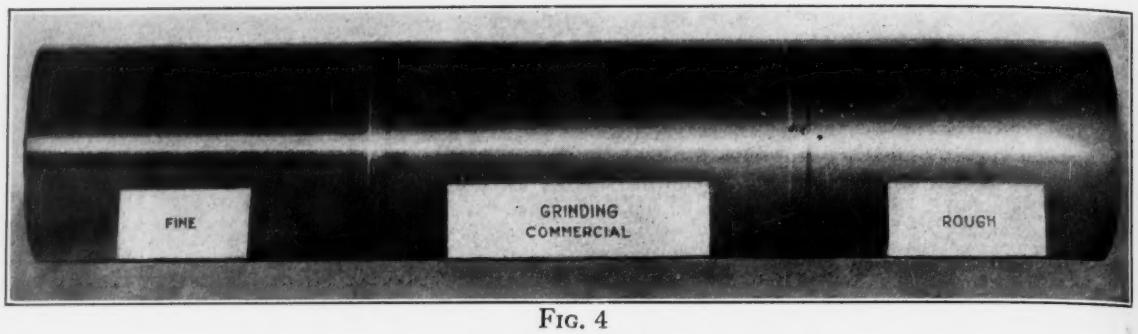


FIG. 4
Grinding Finishes

variety of parts on a jobbing basis, and these comprise the larger part of the manufacturing machine shops of the country.

As a result of this situation, one of several things may happen, all involving a loss of time and consequently extra cost:

1. The mechanic, to prevent criticism, may machine a part all over with a high finish. As high finishes are only necessary where two parts run, slide, or are forced together, a rougher surface will be satisfactory on other portions of the part except in those cases where the finish is used for appearance only.

2. The mechanic, or foreman, may go to the designer for information as to what is necessary, or may go to the assembly floor to study the requirements of the assembled mechanism, should one be available.

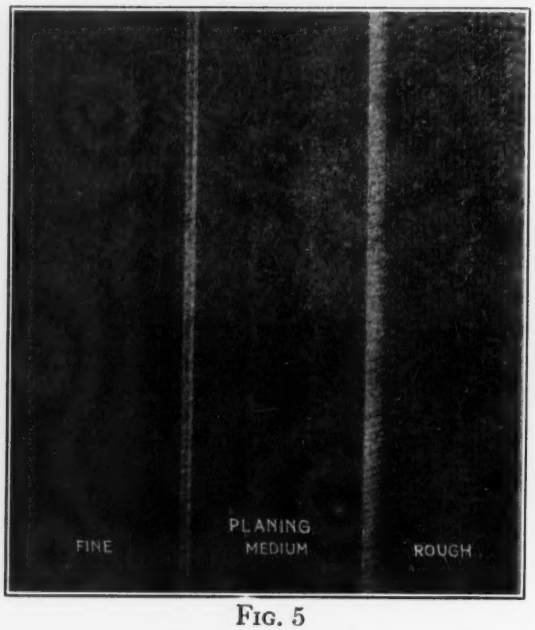


FIG. 5
Planing Finishes

3. A difference of opinion as to the sort of finish really necessary may arise between foreman and workman, or workman and inspector. This results usually in scrapped parts, although the matter may be carried on to the engineering department for final decision. In any event considerable time has been lost, and the time indirectly charged to the pieces in question has been considerably increased.

To overcome the difficulties enumerated, some form of specification of the type of surface is necessary.

Before anything can be definitely done, the engineering department, shop, and inspection department must come to an agreement as to just what types of finish are necessary, and just how each type of surface should appear.

The author has found that the best method of procedure is to prepare a series of samples, employing the various types of machines in use at the shop in question. These samples are discussed by the heads of the engineering, shop, and inspection departments as to their suitability for various classes of work. It has been found that three classes of finish are satisfactory for almost any work: a fine finish, a commercial finish, and a rough finish.

Figures 1 to 11, inclusive, show such standard samples. These photographs were made at the Norton Company, Worcester, Massachusetts, of the standard samples used in their grinding-machine division as shop standards, after extensive experiments had been conducted by them to determine just what degree of finish was required for the various parts of their machines.

These finishes are possibly somewhat higher in grade than might be required in some shops because of the extremely high grade of workmanship necessary in building grinding machines.

Figure 3 shows a milled thread, such as might be used for lead screws and would be represented as a high finish. The grinding finishes shown in Figure 4 do not include the mirror finishes

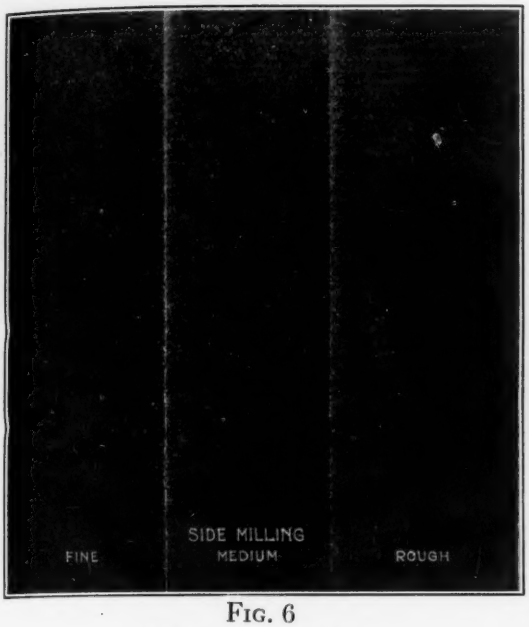


FIG. 6
Side-Milling Finishes

sometimes required in rolls for aluminum foil, copper, and other soft metals.

Keyways at Norton are all high finish, as shown in Figure 10. In a rougher class of work, a lower grade of keyways might be permissible.

In preparing the samples, feeds and speeds should be used representing ordinary shop practice, so that the finishes may be readily duplicated on commercial work. It has been found desirable to make up samples showing the following types of finish:

I. TURNING (on lathes or boring mills):
a. High finish—for journals, etc.
b. Commercial finish—used for press fits, bolts, portion of shafts, rough fits, etc.
c. Rough finish—used where it is necessary only to remove stock for clearance, or to put part in balance.

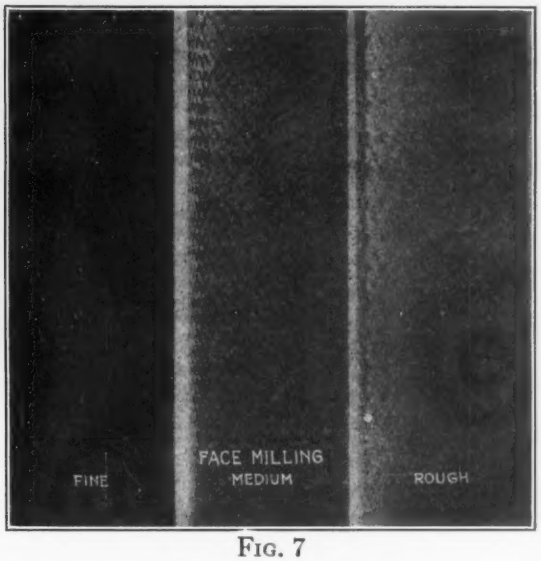


FIG. 7
Face-Milling Finishes

II. THREAD CUTTING:
a. High finish—for all precision screws.
b. Commercial finish—for bolts or for rough screws for transmitting motion at low speeds.

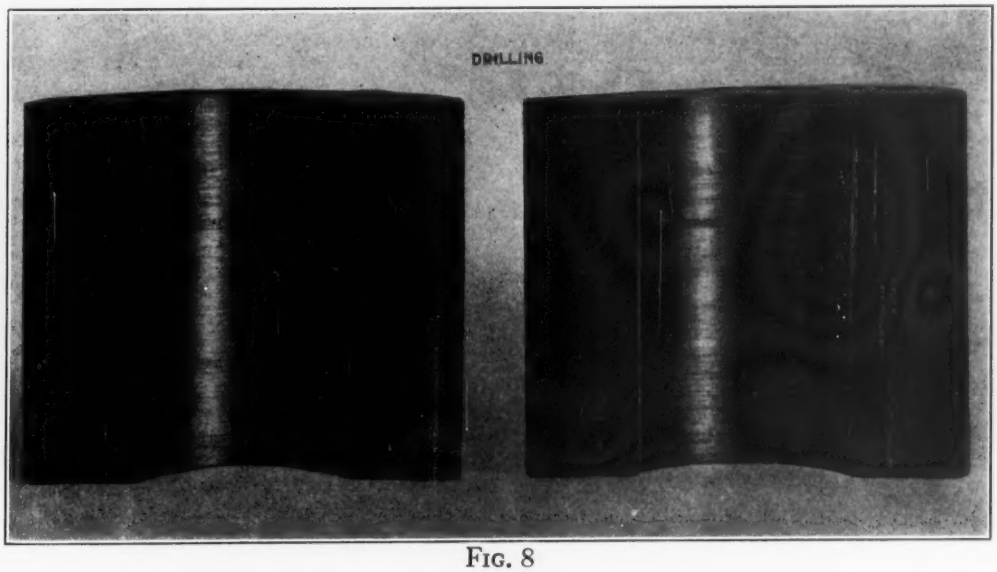


FIG. 8
Drilled Holes

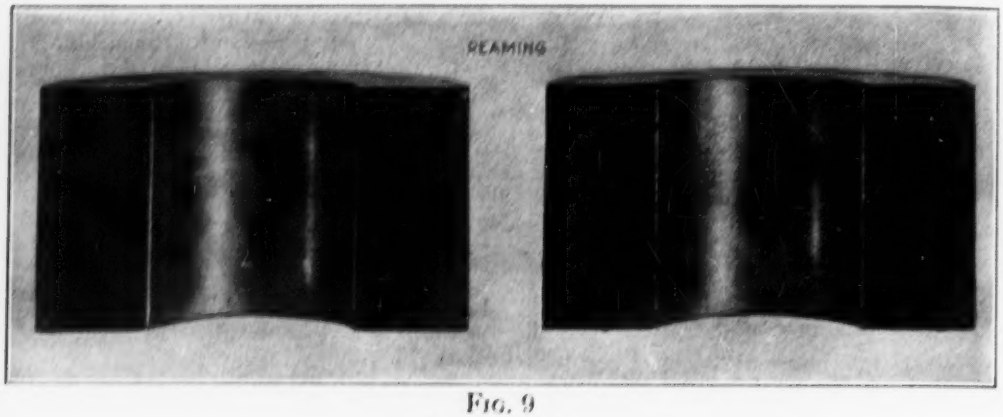


FIG. 9
Reamed Holes

III. BORING:
a. High finish—used for bearing or press fits.
b. Commercial finish—may be used where mating surfaces are used only for locating purposes.
c. Rough finish—used where stock is removed only to provide clearance or to put part into balance.

IV. GRINDING: (The mirror finishes used for rolls, etc., are not listed. Where used they should be standardized.)
a. High finish—used for bearings, either for rotating or sliding members.
b. Commercial finish—used for force fits.
c. Rough finish—usually used for truing up hardened pieces where surface is not used.

V. PLANING AND SHAPING:
a. High finish—used for bearing surfaces.
b. Commercial finish—used for surfaces bolted permanently together.
c. Rough finish—used to remove stock for clearance.

VI. SIDE MILLING:
a. High finish—used for bearing surfaces.
b. Commercial finish—used for surfaces bolted permanently together.
c. Rough finish—used to remove stock for clearance.

VII. FACE MILLING:
a. High finish—used for bearing surfaces.
b. Commercial finish—used for surfaces bolted permanently together.
c. Rough finish—used to remove stock for clearance.

VIII. DRILLING AND REAMING:
a. Reamed hole—used wherever close fit is necessary.
b. Drilled hole—used for clearances—as bolt holes.

IX. KEYWAY CUTTING:
a. High finish—accurately fitting key or slide key.
b. Commercial finish—unimportant key.

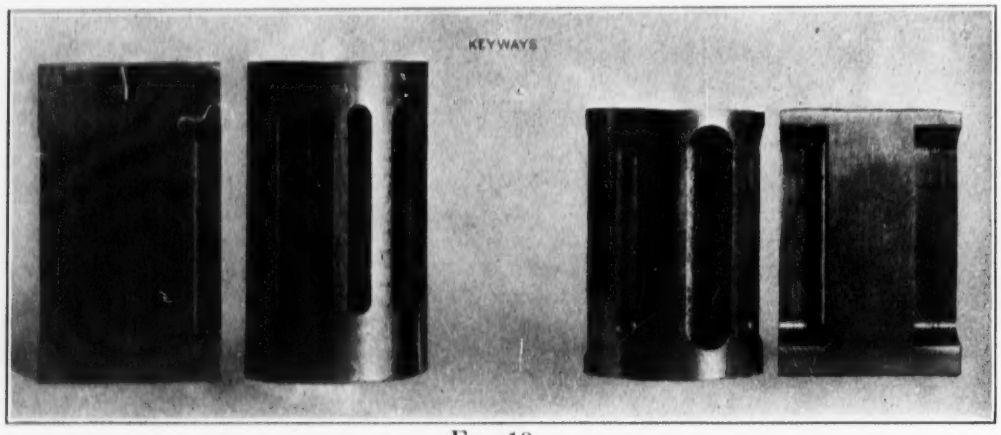


FIG. 10
Keyway Finishes

X. POLISHING:
a. High finish—used for appearance, as on handles and handwheels.

XI. LAPPING:
a. High finish.
b. Commercial finish.

To indicate these finishes on a drawing some simple, unmistakable symbol system is necessary. Those following, which are in part those used in Germany and Sweden, seem to fill the need adequately:

- Rough finish (any machine)
- Commercial finish (any machine)
- High finish (any machine)
- The rough unfinished surface of castings or forgings
- Surface chipped and filed to size
- Surface scraped to fit

The connecting rod illustrated in Figure 12 shows just how these symbols would be used on a drawing. The black circles indicate clearly those portions of the rough surface that are to be left untouched. The two faces are to have a second-class finish, presumably with a face mill, as shown in Figure 7, the $4\frac{3}{4}$-in. round opening is to be reamed or finish-bored to a high finish, while the rectangular opening will be slotted to a commercial finish. As can be seen from this drawing, the symbols are clearer than the commonly used "*f*," and in addition give much more information without encumbering the drawing with notes.

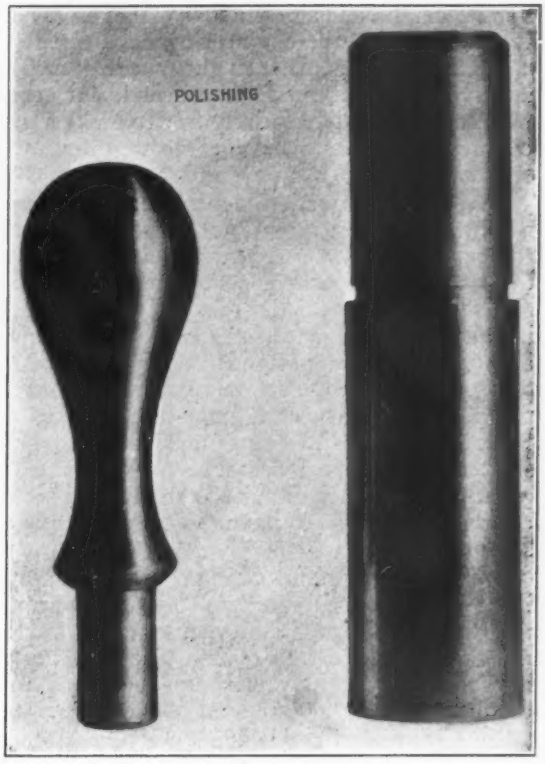


FIG. 11
Polishing

The foregoing series have the merit of not requiring the engineering department to specify anything regarding the machining of the surface other than its final appearance. The sixth symbol may not be universal in its application,

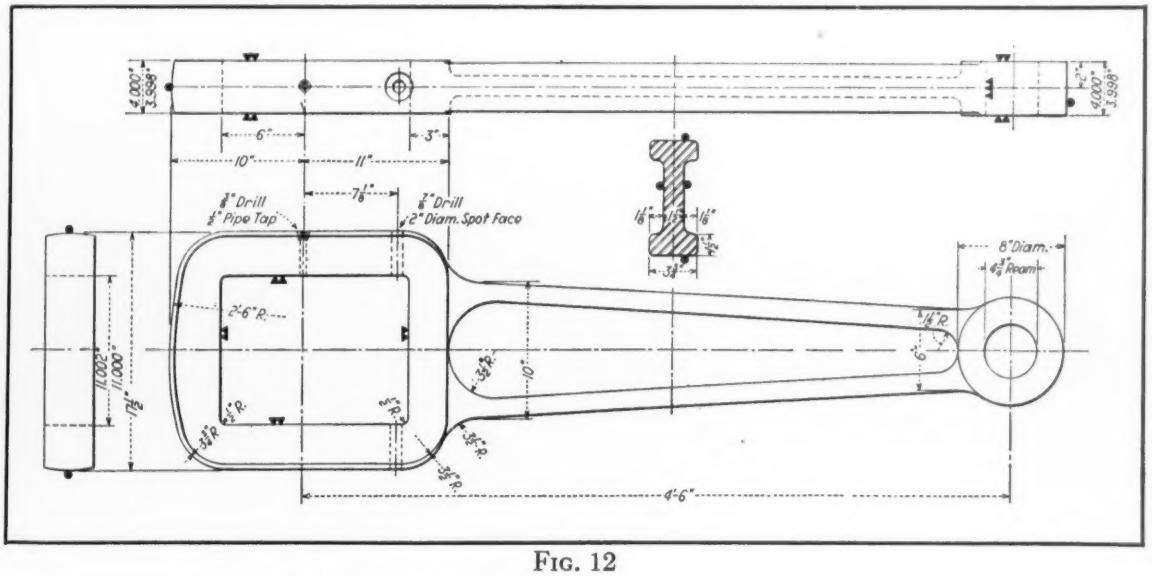


FIG. 12
Showing How Finish Symbols Are Indicated on Working Drawings

but it will have value in many shops. These symbols require the engineering department to indicate in some other manner when a part must be ground, lapped, or polished, but otherwise the shop is left entirely free to make a part in the way that it believes to be the most economical.

Shop and inspection departments will save much time and argument, not only by specifying the type of finish but by giving a clear idea as to just what constitutes each type of finish on a given machine. To do this it is desirable to install in each department a cabinet containing a set of samples protected against rust. In doing this the engineering and inspection departments should each have a complete set, while the machining departments should have sets covering only those surfaces they are engaged in reproducing. For example, the planer department needs to have only a set of planer samples.

Specifications of machining surfaces, as outlined in the preceding pages, may be set up in any shop, either small or large, at a very moderate cost, provided they go into effect at first on new parts only. It is relatively simple to change old drawings as they are used for new lots.

An extension of this idea will undoubtedly come in time in the national or international standardization of these finishes. To accomplish this, much work will be necessary. The industries of the country must agree as to what constitutes each class of finish, and must then write specifications so definite that a surface produced in any shop will be quite comparable with that produced in any other shop. This can be done by specifying the depth of tool marks, as measured by an optical comparator or some similar instrument, and also a tolerance for each class of finish.

To recapitulate, it is believed that the advantages to the average machine shop from the specification of machined surfaces would be comparable only to those resulting from the use of tolerances, which are generally conceded. In addition it will be possible to introduce such specifications much more readily, and at a much lower cost, than was the case with tolerances. Should a national standard be set up it will greatly facilitate the production of parts in a shop other than the one in which they were designed—a practice which is becoming increasingly more prevalent. A company having no shop at all may design a machine and send its drawings out to a jobbing shop where it is to be built, and one with a shop may do the same when its facilities are overcrowded. A national standard would be particularly desirable for ordnance work, which, in time of emergency, may have to be done in any shop in the country.

Discussion

R. E. W. HARRISON: The proposals outlined in Mr. Deale's article come at a very opportune time, inasmuch as the demand for the maintenance of the original tolerances in high class machinery is increasing.

The purchasers of automobiles, domestic refrigerators, phonographs, sewing machines, and other domestic appliances of a mechanical nature, all of which are used in vast quantities, are expecting and insisting on a longer period of usage before the inevitable wear makes the appliance noisy or in other ways unsatisfactory for its original purpose. Even the introduction and quite general use of anti-friction bearings does not entirely eliminate the eventual unsatisfactory performance of the mechanism, as these elements in turn are subject to wear.

Particularly is the foregoing thought exemplified in the modern automobile—many of which will continue to perform without perceptible evidence of wear resulting in noise after 20,000 miles of usage.

While much has been done by competent lubrication engineers to eliminate the metal-to-metal contact between load-carrying elements, the true function of the lubricant has been shown impossible of attainment if the working surfaces are not properly prepared.

While the advent of the precision grinding machine probably represents the most forward step recorded during the past 50 years in the making of working surfaces with a reduced potential wear, the demands for quiet and efficient performance have grown to such an extent that there has arisen a very real commercial necessity for an engineering control of the processes of finishing and a means whereby the engineer can quickly and clearly convey his requirements to the personnel, whose function it is actually to manufacture the mechanical components.

Careful research, coupled with practical experience based on the operation of a great number of mechanisms in service, indicates that each one of the generally accepted machined surfaces or finishes of today has, under given load and lubrication conditions, a definite potential wear, and manufacturers have realized that it is entirely futile to specify extremely close tolerances on surfaces which possess this relatively high factor of potential wear. No better example can be quoted than the automobile piston pin, as this element, probably more than any other in the modern automobile, is stressed more highly in proportion to its area than any other of the load-carrying elements.

Improperly finished piston pins may have as high a potential wear as 0.0005 in. on the diameter after, say, an eight-hour run in the

engine, and it therefore follows that when manufacturing this pin it is a futile waste of money to specify a total tolerance of 0.0002 in.

It was with the thought in mind of drawing attention to this phase of manufacturing conditions that the writer presented his paper at the A.S.M.E. Annual Meeting on December 4, 1930.[2]

Already considerable experience has been gained in the control of the quality of grinding finishes along the lines of the scheme described in this paper, and sufficient evidence is forthcoming to indicate that it not only enables the engineer to control his tolerances, but in addition it makes for real economies in the cost of manufacture.

That this scheme of designating and controlling finishes should be extended to surfaces machined by other processes is only logical, and Mr. Deale's proposal to extend the application to drawings calling for turning, boring, milling, and planing operations is in line with sound economics from the points of view of both the engineer and the manufacturing superintendent.

Another important benefit will be made available to the mechanical engineering industry by the establishment of national standards. Under present conditions the quality of surface to be produced by a newly installed machine tool is more often than not a matter of opinion. The limits of deviation from a nationally acceptable standard are not defined, and it is reasonable to assume that the misunderstandings which occasionally arise, due to this factor alone, cost the industry a considerable amount of expense.

The general acceptance of the fact that the cost of production increases or decreases precisely as the quality and accuracy of the surface produced will help materially to a realization that the correct specification of surface standards is an economic necessity.

The manufacturing procedure which is now generally followed, as described by Mr. Deale, whereby the quality of vitally important surfaces is determined in conference by the engineering department, shop, and inspection department, is crude and costly in the extreme, and occasionally results in the acceptance of a finish which one of the departments concerned honestly believes is below that required for the particular mechanism in question. With suitable reference standards, together with a standardized procedure for obtaining these results, the costly conference arguments and time spent in experimental try-outs can be practically eliminated, and in addition to this, the cost-estimating and recording departments can do their work in a more positive way without the element of guessing which now so frequently leads to the injection of a safety factor into cost estimates, which at times proves a real embarrassment to the commercial end of the business.

Discussions with the engineering and manufacturing personnel of many of the leading manufacturers in the mechanical engineering industry have convinced the writer that action in this direction is overdue and would be welcomed by all concerned; especially, as in this move we have the opportunity for the establishment of manufacturing standards in a way which will not interfere with present manufacturing processes, and the reference standards cannot from their very nature be costly to manufacture.

Furthermore, the extreme simplicity of the scheme of finish designation will enable the standards to be established in both the engineering department and the shop with the least possibility of a misunderstanding.

[2] The paper "A Survey of Surface Quality Standards and a Study of Tolerance Costs," is published on page 4 of this issue of the ASA BULLETIN.

New Electrical Committee Holds Organization Meeting

The organization meeting of the new Electrical Standards Committee was held on October 13, as a joint meeting with the former Electrical Advisory Committee which adjourned *sine die* at the conclusion.

Charles Rufus Harte, construction engineer of the Connecticut Company, New Haven, Connecticut, was elected chairman, and H. P. Charlesworth, vice-president, Bell Telephone Laboratories, New York, was elected vice-chairman. The following Executive Committee was also elected:

C. H. Harte

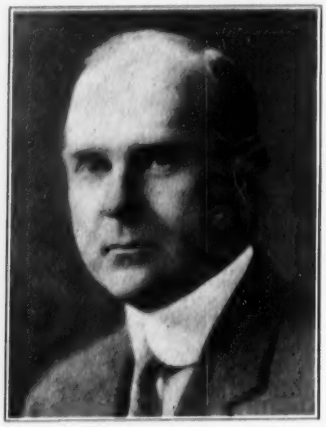
C. R. Harte, construction engineer, the Connecticut Company, New Haven, Conn., *chairman*

L. L. Elden, technical advisor to the general superintendent, Edison Electric Illuminating Company, Boston, Mass., representing the Electric Light and Power Group

H. L. Huber, Engineer on Foreign Wire Relations, American Telephone and Tele-

graph Company, New York, member-at-large

S. L. Nicholson, acting vice-president, Westinghouse Electric and Manufacturing Company, New York, representing the National Electrical Manufacturers Association



H. P. Charlesworth

L. T. Robinson, engineer-in-charge, General Engineering Laboratories, General Electric Company, Schenectady, N. Y., representing the American Institute of Electrical Engineers

A. R. Small, vice-president, Underwriters' Laboratories, New York, member-at-large

The appointment of a committee on scope of the ESC was authorized. The personnel of the committee will be as follows:

Alexander Maxwell, Engineer, National Electric Light Association, representing the Electric Light and Power Group, *chairman*

H. S. Osborne, Transmission Engineer, American Telephone and Telegraph Company; *alternate*, H. E. Farrer, secretary, Standards Committee, A.I.E.E., representing the American Institute of Electrical Engineers

L. F. Adams, commercial engineer, General Electric Company; *alternate*, C. M. Cogan, secretary, Standards Committee, N.E.M.A., representing the National Electrical Manufacturers Association

The report of a subcommittee dealing with a revision of Section 15 of the ESC constitution, which covers the international phases of the work, was approved. This report makes specific provision for the appointment of three representatives by the American Society of Mechanical Engineers upon the new United States National Committee of the International Electrotechnical Commission.

The committee approved the personnel of the sectional committee on insulators for electric power lines (C29) and ordered to letter ballot of the ESC the revised standards for electric railway control apparatus (C48) for recommendation to the Standards Council on approval.

The Committee on Scope was instructed to review the personnel and organization of the sectional committee on insulated wires and cables (C8) with a view to simplifying the committee's set-up, and to look into the following projects submitted by the A.I.E.E. and to make recommendations on the most appropriate method of handling them:

Recommendations for the Operation of Transformers (C53)

Constant Current Transformers of the Moving Coil Type (C54)

Capacitors (C55)

60-cycle Test Voltage for Standard Bushings for Transformers (C56)

Transformers, Induction Regulators, and Reactors (C57)

The next meeting of the Electrical Standards Committee will be held on December 1, 1931.

Dr. Lewis Taylor Robinson, Long Active in ASA, Dies

Lewis Taylor Robinson, engineer in charge of the General Engineering Laboratory, General Electric Company, died suddenly of a heart attack at his home in Schenectady on November 3.

Dr. Robinson was one of the best known members of the electrical engineering profession and had been head of the General Engineering Laboratory since its inception about 12 years ago. He was affiliated with the American Standards Association since its organization as the American Engineering Standards Committee as a representative of the American Institute of Electrical Engineers. He was prominently connected with the standardization work of the A.I.E.E. for many years, serving as chairman of its standards committee in 1919-20.

He did considerable work as a member of the U.S. National Committee of the International Electrotechnical Commission, especially as a member of the committee on rating and its subcommittee on temperature rise. During the summer of 1929 and 1930, he attended meetings of the I.E.C. in Germany, Denmark, Sweden, and Norway. As a result of these visits, Dr. Robinson prepared a memorandum concerning the procedure in electrical standardization in foreign countries and looking to a more systematic development of electrical standardization in this country, which he transmitted to the A.I.E.E. The memorandum was endorsed by the Board of Directors of the A.I.E.E. and transmitted to ASA. A small subcommittee, of which Dr. Robinson was a member, was appointed by the Electrical Advisory Committee to formulate a plan based upon his memorandum.

This work has now resulted in the organization of the Electrical Standards Committee of ASA and Dr. Robinson was unanimously elected a member of its executive committee.

Dr. Robinson was born in Springfield, Massachusetts, on October 20, 1868, and attended the public schools of Lynn and Reading, Massachusetts. He became affiliated with electrical work as office boy for Professor Elihu Thomson of the old Thomson-Houston Electric Company and derived from Professor Thomson his enthusiasm for electrical work. In 1885 he entered the factory headquarters of the Thomson-Houston Company. After a few years he undertook a business venture of his own as junior partner of Whitman and Robinson, conducting a laboratory for the testing and calibration of electrical instruments. Later he was connected with the Schuyler Electric Company at Middletown, Connecticut, which was affiliated with the General Electric Company and which was soon absorbed by it. He was also affiliated with the Central Electric and Foundry Company at Lewisburg, Pennsylvania. In 1896 he went to Schenectady and took charge of the standardizing laboratory of the General Electric Company, which was consolidated in 1919 with the Consulting Engineering Laboratory founded by the late Dr. Steinmetz to form the General Engineering Laboratory.

In the General Engineering Laboratory under

L. T. Robinson

Dr. Robinson's direction, many notable electrical instruments and devices were developed. Among these were new types of electrical measuring instruments and electrical transformers, the electrocardiograph, the oscillograph, early developments of the power mercury arc rectifier, and the photophone, a system of recording sound on photographic film. Dr. Robinson had received 30 patents.

In 1929, Union University conferred on Dr. Robinson the degree of Doctor of Science "as a student in the truest sense of the word."

Los Angeles Representative Appointed by ASA

George M. Richardson, purchase engineer, Southern California Edison Company, Los Angeles, California, who is president of the National Association of Purchasing Agents, has been appointed by the American Standards Association as its local representative in Los Angeles. Mr. Richardson will act as the point of contact between the industries of Los Angeles and Southern California and ASA. Copies of all standards approved by ASA and of all ASA publications will be on file in Mr. Richardson's office. This file may be consulted by any one interested, and copies may be ordered through Mr. Richardson's office.

Date of Western Electric Company Standardization Corrected

In the report of the discussion by Harry E. Harris, Consulting Engineer, Bridgeport, Connecticut, in the "Abstract of Discussion of Osborne Paper on Standardization in the Bell System," published on page 26 of the October issue of the ASA BULLETIN, Mr. Harris is reported as having said in connection with the standardization work of the Western Electric Company:

> "In *1911* we used a box with 24 compartments containing the adjusting screws for adjusting the platinum button bar on the old Edison-Blake transmitter."

Instead of *1911* in this statement, the year should have been reported as *1899*.

Mr. Harris points out that by 1911 the Western Electric Company was in a highly standardized condition and that the standardization and research work on machine screws was done in 1902–1904.

Industrial Thermometers

The Federal Specification Board has just issued a revision of Federal Specification 472a (GG-T-321), Industrial Thermometers. This specification covers material, workmanship, sampling, inspection, tests, packing, and marking of thermometers. Copies are available at five cents each.

ASA PROJECTS

A Review of Safety Code Projects under ASA Procedure

The first of a series of reviews of standardization projects under the procedure of the American Standards Association

The status of all safety code projects under ASA procedure is summarized in the following review. The data presented are taken from the files of the American Standards Association and are corrected to November 1, 1931, bringing up-to-date the review of safety code projects published in the December, 1930, issue of the ASA BULLETIN. The personnel of the sectional committees handling the projects may be found by reference to the project section of the 1931 American Standards Association Year Book (pages 28–79).

A9-1929—Building Exits Code

Sponsor—National Fire Protection Association.

Chairman—John Irvin Bright, Ardmore, Pa.

Secretary—Robert S. Moulton, National Fire Protection Association, Boston, Mass.

Scope—Methods of effecting exit from buildings, including doors, halls, stairways, ramps, fire escapes, and the amount of exit capacity required for different classes of occupancies, with particular reference to the needs for exit in emergency from places of employment, and of public assembly, etc.

This code was approved as American Tentative Standard, September 11, 1929.

A10—Construction Work

Sponsors—National Safety Council; American Institute of Architects.

Chairman—W. R. Smith, Assistant Chief Engineer, Newark Office, United Engineers and Constructors, Inc.

Secretary—W. Dean Keefer, Chief Engineer, National Safety Council, Chicago, Ill.

Scope—Construction, demolition and repair of buildings; including excavation, foundation work, steel erection, scaffolding, lighting, openings, temporary floors and stairs in relation to accident hazards to employees and to the public.

During the past year the personnel of the sectional committee was completed and, together with the scope for the project, was approved by Standards Council. Six subcommittees with their chairmen and secretaries have been appointed and are now actively engaged in the preparation of drafts of the sections of the general code assigned to them. A meeting of the sectional committee was held in Chicago on Thursday, October 15, at which time agreement was reached on methods of carrying on the work. Proposals were made as to the promotion of the use of the code after it has been completed.

A11-1930—Lighting of Factories, Mills, and Other Work Places

Sponsor—Illuminating Engineering Society.

Chairman—Ward Harrison, National Lamp Works, Cleveland, Ohio.

Secretary—William F. Little, Electrical Testing Laboratories, New York, N. Y.

Scope—Recommended values for illumination for different classes of work in factories, mills, and other work places; specifications for the minimum illumination required from the point of view of safety in traversed places during the time of use, or while work is in progress; rules for the avoidance of glare; rules for installation of exit and emergency lighting.

This code was approved as an American Standard on August 18, 1930.

A12—Floor and Wall Openings, Railings and Toe Boards

Sponsor—National Safety Council

Chairman—S. E. Whiting, Chief Engineer, Liberty Mutual Insurance Company, Boston, Mass.

Secretary—W. Dean Keefer, Chief Engineer, National Safety Council, Chicago, Ill.

Scope—Rules applicable to places of employment having exposure to the hazards of falling persons or falling materials, including floor openings and runways, with provisions for railings and toe boards.

The final draft of this code has been prepared and submitted to letter ballot of the sectional committee. This draft, together with the complete records concerning its development and vote of the committee, is now before the sponsor for consideration in connection with recommending its approval by the American Standards Association.

A14—Ladders

Sponsor—American Society of Safety Engineers, Engineering Section, National Safety Council.

Secretary—M. G. Goodspeed, General Electric Company, Erie, Pa.

Scope—Rules governing the safe construction and use of ladders of various types, including fixed, portable, extension, fire, step, trolley, sectional, and trestle.

The special subcommittee which has been considering the criticisms received of the last tentative draft, prepared by the sectional committee, has completed its recommendations to the sectional committee in the form of a new draft. It is expected that this new draft will be submitted to the committee for approval by letter ballot within a short time.

A17-1931—Elevators, Dumbwaiters, and Escalators

Sponsors—American Institute of Architects; American Society of Mechanical Engineers.

Chairman—Sullivan Jones, New York, N. Y.

Secretary—John A. Dickinson, Bureau of Standards, Washington, D. C.

Scope—Construction, maintenance, and operation of elevators, dumbwaiters, escalators and their hoistways, but not including conveyors, skip hoists, amusement devices, or elevators of capacity exceeding 30,000 pounds and platform area exceeding 300 square feet when suspended by cables near each corner of the hoistway and at additional positions, nor to elevators used only during building construction.

The revision of this code was approved as American Standard on July 9, 1931.

A22—Walkway Surfaces

Sponsors—American Institute of Architects; American Society of Safety Engineers, Engineering Section, National Safety Council.

Scope—Pertinent walkway surface characteristics; including resistance to slipping, freedom from tripping hazard, durability, flammability, insulation, as well as non-slip characteristics of walkway surfaces around electrical apparatus; general and maintenance requirements. For use in apartment houses, factories, and other work places, office buildings, hospitals, hotels, and restaurants, railway cars, railway stations, and train platforms, schools and theatres; for elevator floors, elevator landings, corridor floors, and door thresholds, ramps, runway floors, stairs and fire-escape treads and landings, sidewalks, accessories to buildings, including coalhole covers, sidewalk doors and gratings, floors and platforms around moving machinery and electrical apparatus.

The special subcommittee charged with developing a final draft of this code has been unable to prepare a draft which could be accepted by the sectional committee. The subcommittee is now engaged in an additional attempt to meet the criticisms of past drafts which have been prepared.

A23—Lighting of School Buildings

Sponsors—Illuminating Engineering Society; American Institute of Architects.

Chairman—H. H. Magdsick, General Electric Company, NELA Park, Cleveland, Ohio.

Secretary—H. B. Dates, Case School of Applied Science, Cleveland, Ohio.

Scope—Rules for intensity of illumination required, avoidance of glare, distribution of artificial light, color and finish of interior, location of switching and controlling apparatus, exist and emergency lighting, inspection and maintenance, blackboard lighting. Excludes subject of fire hazard from illumination sources.

The sectional committee which has undertaken the revision of this project has prepared two drafts of the proposed new code. The second draft was preprinted for presentation to the Convention of the Illuminating Engineering Society in Pittsburgh on October 16. Among the topics for revision which are being considered by the sectional committee are "Effect of Glare," "Color of Ceiling and Walls," and "Luminaries." This draft is subject to further action of the committee and of the sponsors.

A39—Window Washing

Sponsor—National Safety Council.

Chairman—G. F. Collins, Manager, Peoples Gas Building, Chicago, Ill.

Secretary—G. E. Burns, National Safety Council Chicago, Ill.

Scope—All window washing operations performed on the outside of office buildings and mercantile establishments more than one story high, or in which the sills of windows are located more than ten feet above grade or adjoining flat roof.

The fifth draft of this code was submitted to members of the sectional committee on May 29, 1931. Several criticisms and suggestions were received which prevented submission of the draft to the committee for final approval. Changes in the draft are now being made to meet these suggestions.

B7-1930—Abrasive Wheels

Sponsors—Grinding Wheel Manufacturers Association of the U. S. & Canada; International Association of Industrial Accident Boards and Commissions.

Chairman—Swen Kjaer, Bureau of Labor Statistics, Washington, D. C.

Secretary—A. Rousseau, Norton Company, Worcester, Mass.

Scope—Rules and specifications necessary to insure safety in the use of abrasive wheels operating at surface speeds in excess of 2000 feet per minute.

The specifications relate to protective hoods, flanges, bands and chucks, and rules for the proper mounting and safe operation of wheels are included.

This code was approved as an American Standard, June 25, 1930.

B8—Foundries

Sponsors—American Foundrymen's Association; National Founders' Association.

Chairman—F. H. Elam, Manager, Casualty Department, American Steel Foundries, Chicago, Ill.

Scope—Protection of workers in foundries making castings from iron, steel, aluminum, brass, bronze, and other similar alloys. The code deals exclusively with conditions in the foundry proper.

The sectional committee engaged in the revision of this code prepared a final draft which was submitted to the sectional committee for approval. Several negative votes were received, with suggestions for changes. These suggestions have been sent to the membership of the committee for their further consideration before final letter ballot is taken on the approval of this revision.

B9-1930—Mechanical Refrigeration

Sponsor—American Society of Refrigerating Engineers.

Chairman—F. E. Matthews, Leonia, N. J.

Secretary—R. R. Leonard, American Society of Refrigerating Engineers, New York, N. Y.

Scope—Safe installation, operation, and inspection of refrigerating systems; also the storage of refrigerants; applies to every refrigerating equipment employing fluids which are vaporized and liquefied or compressed in their refrigerating cycle.

This code was approved as an American Standard on October 30, 1930.

B11-1926—Power Presses and Foot and Hand Presses

Sponsor—National Safety Council.

Chairman—C. B. Auel, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Secretary—W. Dean Keefer, National Safety Council, Chicago, Ill.

Scope—Safety requirements relating to all power presses, foot presses, and hand presses; *viz.*, machines fitted with rams and dies for the purpose of blanking, trimming, drawing, punching, or stamping material, also including plate shears and plate punches, but not including bulldozers, hot-metal presses, hammers, bending presses or brakes, power screw or fitting presses, air presses, and hydraulic presses.

This code was approved as an American Standard, November 11, 1926.

B13-1924—Logging and Sawmill

Sponsor—U. S. Department of Commerce, Bureau of Standards.

Chairman—R. McA. Keown, Wisconsin Industrial Commission, Madison, Wis.

Secretary—J. A. Dickinson, Bureau of Standards, Washington, D. C.

Scope—Logging operations including the transportation of logs to the mill; to the ordinary sawmill operations including lath and shingle manufacture, but excluding the manufacture of veneer and cooperage stock; to dry kilns and yard operations.

This code was approved as American Tentative Standard January 12, 1924.

B15—Mechanical Power Transmission Apparatus

Sponsor—American Society of Mechanical Engineers; International Association of Industrial Accident Boards and Commissions; National Bureau of Casualty and Surety Underwriters.

Chairman—C. B. Auel, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

Secretary—Thomas M. Nial, Hartford Accident and Indemnity Company, New York, N. Y.

Scope—Safeguarding of moving parts of equipment used in the mechanical transmission of power, including prime movers, intermediate equipment, and driven machines, excluding point of operation. This includes connecting rods; cranks; fly wheels; shafting; spindles; pulleys; belts (except flat belts one inch or less in width; or round belts one-half inch or less in diameter); link belts; chains; ropes and rope drives; gears; sprockets; friction drives; cams; couplings; clutches; counter weights; and other revolving or reciprocating parts, up to but not including the point of operation.
Also in process of development: Safety provisions for construction and operation of governors, clutches, belt shifters, and other mechanical means of controlling power.

This code is under revision but the sectional committee has been unable to hold any meetings for some time. It is expected that it will be six months before any definite action can be reported.

B19—Compressed Air Machinery

Sponsors—American Society of Mechanical Engineers; American Society of Safety Engineers, Engineering Section, National Safety Council.

Chairman—H. D. Edwards, Linde Air Products Company, New York, N. Y.

Secretary—William C. Straub, Chicago Pneumatic Tool Company, New York, N. Y.

Scope—Rules for the construction and use of compressors, tanks, pipe lines, and the utilization apparatus where compressed air is the active agent.

No progress can be reported in the development of this code. A tentative draft, prepared for the sponsors by the Industrial Division of the National Safety Council, was sent to the members of the sectional committee in February,

1930. The committee has not voted on this draft and very little constructive criticism has been received. No meeting of the committee has been held because it has been impossible to secure sufficient attendance.

B20—Conveyors and Conveying Machinery

Sponsors—American Society of Mechanical Engineers; National Bureau of Casualty and Surety Underwriters.

Chairman—Charles H. Newman, Society of Terminal Engineers, New York, N. Y.

Secretary (temporary)—John A. Dickinson, Bureau of Standards, Washington, D. C.

Scope—Safe operation and maintenance of gravity, belt, chain flight, bucket, apron, screw and jigging conveyors, car hauls, aerial cableways, overhead trolleys, and pneumatic tubes.

No meeting of the sectional committee for this project has been held since October 1, 1929, but various subcommittees have been at work. Two of these subcommittees—3, on Gravity Conveyors and Chutes, Live Roll Conveyors, and 5, on Cable Conveyors—have completed drafts of certain sections of their work. These are to be distributed to the members of the sectional committee for comment within a short time.

B24-1927—Forging and Hot Metal Stamping

Sponsors—American Drop Forging Institute; National Safety Council.

Chairman—G. A. Kuechenmeister, Dominion Forge and Stamping Company, Walkerville, Ontario.

Secretary—W. Dean Keefer, National Safety Council, Chicago, Ill.

Scope—All classes of power-forging machinery for both drop forging and flat-die forging, including steam hammers, pneumatic hammers, mechanically operated hammers, hydraulic presses, trimming presses, bulldozers, upsetting machines, and bolt-heading and rivet-making machines, hot saws; and incidental operations in connection with such machinery.

This code was approved as American Recommended Practice on April 8, 1927.

B28—Rubber Machinery

Sponsors—International Association of Industrial Accident Boards and Commissions; National Safety Council.

Chairman—J. E. Congdon, United States Rubber Company, New Haven, Conn.

Scope—The mechanical hazards encountered in the manufacture of rubberized fabrics, rubber tires, fire and garden hose, footwear, molded rubber goods, rubber belting, reclaimed rubber, rubber solution, and products made therefrom, and miscellaneous rubber materials; the machines used in breaking down, washing, milling, cutting, molding, and vulcanizing of rubber, together with calenders, spreaders, coaters, and dryers, and other machinery used in the manufacture of rubber sheeting; special machines used in the manufacture of rubber tires included, but spinning and weaving of fabrics excluded.

The section of this code covering Rubber Mills and Calenders—B28a, was approved as American Recommended Practice on March 3, 1927.

B30—Cranes, Derricks, and Hoists

Sponsors—American Society of Mechanical Engineers; U. S. Navy Department, Bureau of Yards and Docks.

Chairman (temporary)—J. C. Wheat, Industrial Brownhoist Company, Cleveland, Ohio.

Secretary (temporary)—B. F. Tillson, Consulting Engineer, Caldwell, N. J.

Scope—Structural and operating rules for safety of overhead, gantry, and locomotive cranes, derricks, hoists and slings and chains; but not including apparatus used in mines.

On September 15 the sponsors for this project reported that the sectional committee had prepared three of the five proposed sections of the code: 1, Overhead and Gantry Cranes; 2, Locomotive, Tractor and Motor Truck Cranes; 5, Jacks. These sections have been referred to an editing committee for editing and correlating purposes. Work on the two remaining sections is progressing and it is expected that drafts of Sections 3, Derricks and Hoists and 4, Miscellaneous Equipment for Cranes and Hoists (Slings, Chains and Hooks, Wire Rope and Attachments, Sheaves and Pulleys) will be submitted to the sectional committee within a very short time.

D1-1925—Aeronautic Safety Code

Sponsor—Society of Automotive Engineers.

Scope—Engineering and technical standards of safety for the design, construction, and testing of aircraft, their power plants, and parachutes; the equipment, maintenance, and operation of aircraft in service; safety standards for the design, equipment, and operation of airdomes and airways, including aids to navigation and signaling equipment; regulations as to signals, lights, and rights of way, including traffic rules for air navigation; qualifications as to experience, training and physical fitness of pilots, masters, crews, and ground engineers for aircraft.

This code was approved as American Tentative Standard on December 7, 1925.

D2—Automobile Headlighting

Sponsors—Illuminating Engineering Society; Society of Automotive Engineers.

Scope—Rules to govern laboratory testing of complete headlighting devices and the requirements to be met by head lamps in such tests.

A joint committee of the sponsors prepared a tentative draft of the revision of this code which was printed and distributed for criticism. These criticisms are now before the special committee for their consideration and the committee hopes to make definite recommendations to the sectional committee within the near future.

D3-1927—Colors for Traffic Signals

Sponsors—American Association of State Highway Officials; U. S. Department of Commerce, Bureau of Standards.

Scope—The use of colored lights on highway vehicles, and of lights and non-luminous signals along highways, and at highway crossings for steam and electric railways. The coordinated relation of color, form, position, and number of signals, and their relation to systems of flashing, moving or other similar lights. Methods of specifying or defining colors for signal purposes.

This code was approved as American Standard, November 15, 1927.

D4—Brakes and Brake Testing

Sponsors—American Automobile Association; U. S. Department of Commerce, Bureau of Standards.

Secretary—H. H. Allen, Bureau of Standards, Washington, D. C.

Scope—The minimum acceptable retardation for various types of motor vehicles under the action of brakes; methods of making actual service tests of brakes.

The sectional committee for this project has been reorganized and the personnel approved by Standards Council. Work on the development of the code has been delayed pending the establishment of a research fund which is to be used for the purpose of carrying on fundamental research on which to base the provisions of the revised code.

D5—Street Traffic Signs, Signals, and Markings

Sponsor—American Engineering Council.

Chairman—William B. Powell, Capem Machinery Corporation, Buffalo, N. Y.

The sponsor for this project has submitted a final draft to ASA for approval as American Tentative Standard. This code is now before the Safety Code Correlating Committee for its consideration before making recommendations to Standards Council.

K2-1927—Gas Safety Code

Sponsors—American Gas Association; U. S. Department of Commerce, Bureau of Standards.

Scope—This code covers that portion of the field of manufactured gas practice which lies within the buildings of the consumer, and has for its purpose the safeguarding of the lives, health, and property of the users of manufactured gas, serving as a guide to persons not familiar with such hazards.

This code was approved as American Standard, December 28, 1925.

K13-1930—Gas Mask Canisters

Sponsor—National Safety Council: Chemical Section; Mining Section; Petroleum Section; Public Utilities Section.

Chairman—E. S. Beaumont, Peoples Gas, Light and Coke Company, Chicago, Ill.

Secretary—R. H. Ferguson, National Safety Council, Chicago, Ill.

Scope—The requirements of this code apply to the identification of all gas mask canisters used to afford protection against harmful gases, vapors, smokes, and mists, also dusts in combination with any of these, whether in industrial plants, in mines, in connection with public utility operations, in rescue work, in fighting fires or any other similar endeavor except as used in connection with military activities.

This code was approved as American Recommended Practice on January 7, 1930.

L1-1929—Textile Safety Code

Sponsor—National Safety Council.

Chairman—Charles H. Eames, Lowell Textile Institute, Lowell, Mass.

Scope—Requirements for plants operating textile machinery and equipment, such as pickers, cards, combing machinery, drawing frames, slubbers, roving frames, ring spinning frames, spinning mules, spoolers, twisters, warpers, slashers, looms, inspection machines, folding machines, bailing presses, sewing machines, cloth singers, washing machines, kiers, mercerizing and tenter frames, mangles, winders, dry cans, dyeing pedders, jigs and vats, color mixers, printing machines, soapers, ageing boxes, pasters, dampeners, calenders, hookers, doublers, extractors, bottles, and other machinery and equipment used for similar purposes.

This code was approved as American Tentative Standard on October 11, 1929.

O1-1930—Woodworking Plants

Sponsors—International Association of Industrial Accident Boards and Commissions; National Bureau of Casualty and Surety Underwriters.

Chairman—Swen Kjaer, Bureau of Labor Statistics, Washington, D. C.

Scope—Safe operation and maintenance of woodworking machinery, including cooperage and making of veneer; deals primarily with the point of operation hazards of woodworking machinery.

This code was approved as American Standard, March 26, 1930.

P1-1925—Paper and Pulp Mills

Sponsor—National Safety Council.

Scope—Safety rules for establishments where paper and/or pulp are manufactured.

This code was approved as American Tentative Standard on January 8, 1925.

Z2—Protection of Heads and Eyes of Industrial Workers

Sponsor—U. S. Department of Commerce, Bureau of Standards.

Chairman—R. R. Sayres, U. S. Department of Commerce, Bureau of Mines, Washington, D. C.

Secretary—M. G. Lloyd, Bureau of Standards, Washington, D. C.

Scope—The mechanical protection of the head and eyes; optical protection of eyes and skin from light and heat rays; protection from splashing metals and liquids and from the direct action of fumes and dust.

The sectional committee of the Safety Code for Foundries has requested the revision of this code in order that specifications for particular types of eye protection for workers in foundries will be developed. These suggestions, together with other suggestions which have been received since the original code was approved, have been submitted to the sponsors for use in connection with the development of a revised code. The U. S. Department of Mines is preparing a new section on Respirators which is to be included as a part of the revised code.

Z4—Industrial Sanitation

Sponsor—U. S. Treasury Department, Bureau of the Public Health Service.

Scope—General sanitary requirements of industrial plants, construction operations, and temporary labor camps, including water supply, drainage, sanitary conveniences, disposition of refuse and waste.

The personnel of the new committee for the development of this code has been approved by Standards Council. The sponsor is contemplating sending to the sectional committee a tentative draft for its consideration.

Z8-1924—Laundry Machinery and Operations

Sponsors—Association of Governmental Officials in Industry of the U. S. & Canada; Laundryowners National Association of the U. S. & Canada; National Association of Mutual Casualty Companies.

Chairman—W. G. Conover, Philadelphia, Pa.

Secretary—Frank E. Buckley, Essex, Mass.

Scope—Safety provisions for equipment used in laundries, with special reference to the point of operation of laundry machinery, such as extractors, tumblers, washers, wringers, ironers, etc. Does not apply to dry cleaning operations. Includes provisions for special ventilation, steam distribution, etc.

This code was approved as American Tentative Standard on June 4, 1924.

Z5—Ventilation Code
Z9—Exhaust Systems

Sponsor—American Society of Heating and Ventilating Engineers.

Chairman (Z9)—F. R. Still, American Blower Company, New York, N. Y.

Scope (Z5)—Safety standards for the construction and operation of mechanisms and devices for such conditioning and renewal of air as to tend to render it fit for human respiration. Incidental to the main object, such ventilation will remove dust, fumes, and gases. Applicable in tunnels, subways, factories, schools, places of public assembly, and other enclosed spaces in which men live and work.

Scope (Z9)—Safety standards for the construction and operation of apparatus for moving material by means of air currents. Applies particularly to those cases where dust, fumes, gases, or other deleterious or useless substances are formed or given off, at some point in a process, and from which they may be removed by blowing, or suction, or by properly arranged hoods or ducts.

In view of the inactivity of the sectional committees of these two projects, the projects have been referred to the Subcommittee on Scope of the Safety Code Correlating Committee in order that a plan may be developed whereby some constructive action can be taken to speed up the development of these codes. The subcommittee will render a report at the next meeting of the SCCC, which will be held within a very short time.

Z12—Prevention of Dust Explosions

Sponsors—National Fire Protection Association; U. S. Department of Agriculture.

Chairman—David J. Price, U. S. Department of Agriculture, Washington, D. C.

Secretary—Hylton R. Brown, U. S. Department of Agriculture, Washington, D. C.

Scope—The prevention of dust explosions in connection with processes and industries producing combustible or explosive dusts, including measures for the prevention of ignition, restriction of potential damage by proper construction and arrangement of buildings, restriction of the production and escape of dust through the control of dust producing processes and equipment, extinguishing methods, and related features. Fire prevention and extinguishing are included since dust explosions may result from fires. This project covers both safety to life and protection of property.

Nine codes in the series on Dust Explosions have been approved as American Standards

since the initiation of this project. These codes are as follows:

Z12a—Installation of Pulverized Fuel Systems. This code was originally approved on July 12, 1927. A revision was undertaken and approved on September 5, 1930.

Z12b—Installation of Pulverizing Systems for Sugar and Cocoa. This code was first approved November 4, 1927. A revision was approved September 24, 1931.

Z12c—Prevention of Dust Explosions in Starch Factories. This code was approved November 4, 1927. A revision was approved September 24, 1931.

Z12d—Prevention of Dust Explosions in Flour and Feed Mills. This code was approved January 12, 1928.

Z12e—Prevention of Dust Explosions in Terminal Grain Elevators. This code was approved January 12, 1928 and reapproved September 24, 1931, after revision.

Z12f—Prevention of Dust Explosions in Coal Pneumatic Cleaning Plants. Approved December 31, 1930.

Z12g—Prevention of Dust Explosions in Wood Flour Manufacturing Establishments. Approved September 24, 1931.

Z12h—Prevention of Dust Ignition in Spice Grinding Plants. Approved September 24, 1931.

Z12i—Use of Inert Gas for Fire and Explosion Prevention. Approved September 24, 1931.

Z13—Amusement Parks

Sponsors—National Association of Amusement Parks; National Bureau of Casualty and Surety Underwriters.

Chairman—George P. Smith, Jr., National Association of Amusement Parks, Germantown, Pa.

Secretary—Charles H. Bowditch, Philadelphia Tobogган Company, Germantown, Pa.

Scope—Specifications and recommendations for the construction, operation, maintenance and inspection of grounds, buildings, structures, devices, apparatus, and equipment to insure the protection of the lives and persons of patrons of amusement parks and amusement devices and the employees engaged in the operation of such parks and devices; but not to include the traveling carnival using portable equipment.

Several of the sections of this code have been prepared by subcommittees of the sectional committee and these are now being edited and correlated and developed into the form of a general code for consideration by the sectional committee.

Z16—Accident Statistics

Sponsors—International Association of Industrial Accident Boards and Commissions; National Council on Workmen's Compensation Insurance; National Safety Council.

Chairman—Leonard W. Hatch, New York State Department of Labor, New York, N. Y.

Scope—Revision of the classification of industries in the standard plan for accident statistics of the International Association of Industrial Accident Boards and Commissions, definitions of terms, the form of reporting accidents, the computation of accident rates, and the classification of causes of accidents, and also the consideration of possible revision of other features of the plan.

A meeting of the sectional committee was held in Chicago, October 14, 1931, to review a combined report of two of the subcommittees. An additional meeting of the committee will be held in the very near future to complete the study of this report and to prepare a final draft for submission to the sectional committee for approval.

Z20—Grandstands

Chairman—Kenneth H. Osborn, Osborn Engineering Company, Cleveland, Ohio.

Secretary—Cyril Ainsworth, American Standards Association, New York, N. Y.

Scope—The design and construction of permanent and temporary outdoor stands and temporary and portable indoor stands for the seating of audiences; stability and strength; volume and facility of exits from the standpoint of flow of traffic and prevention of panic jams; fire hazards and the provision of fire-fighting equipment for wooden or other combustible stands; sanitary arrangements; methods of erection of temporary and portable stands.

The scope for this project and the personnel of the sectional committee have been approved by Standards Council. The chairman of the committee has been appointed and the personnel of the various subcommittees designated. These subcommittees have been placed in charge of definite phases of the work and will prepare tentative drafts for the consideration of the sectional committee.

ASA Annual Meeting

The date of the Annual Meeting of the American Standards Association has been set for December 9. There will be a Board of Directors meeting in the morning, followed by a joint luncheon meeting of the Board and the Standards Council, and a meeting of the Standards Council in the afternoon, all at the Hotel Astor.

Personnel of Committee on Insulators Approved

The following personnel of the sectional committee on Power Line Insulators for Electric Power Lines (C29), which was submitted by the American Institute of Electrical Engineers and the National Electrical Manufacturers Association, sponsors for the project, was approved by the Electrical Standards Committee at its meeting on September 21:

American Ceramic Society—K. A. Hawley, Locke Insulator Corporation, Baltimore, Md.; *alternate*, D. H. Rowland, Locke Insulator Corporation, Baltimore, Md.

American Electric Railway Association—H. E. Bachman, Public Service Railway Company, Newark, N. J.

American Institute of Electrical Engineers—F. W. Peek, General Electric Company, Pittsfield, Mass.; C. L. Fortescue, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.; R. E. Argersinger, Stone & Webster, Boston, Mass.; F. M. Farmer, Electrical Testing Laboratories, New York City; H. B. Dwight, Massachusetts Institute of Technology, Cambridge, Mass.

American Railway Association—G. I. Wright, Electric Traction, Reading Company, Philadelphia, Pa.; G. W. Chappell, New York, New Haven & Hartford Railroad, New Haven, Conn.

National Electrical Manufacturers Association—W. H. Burleson, Ohio Brass Company, Mansfield, Ohio; E. H. Fritz, Westinghouse Electric and Manufacturing Company, Derry, Pa.; G. W. Lapp, Lapp Insulator Company, Inc., Leroy, New York; W. L. Stinson, Jeffrey-Dewitt Insulator Company, Kenova, West Va.; H. B. Vincent, R. Thomas & Sons Company, Lisbon, Ohio

Electric Light and Power Group—J. A. Brundige, Electric Bond and Share Company, New York City; H. S. Phelps, Philadelphia Electric Company, Philadelphia, Pa.; W. G. Kelley, Commonwealth Edison Company, Chicago, Ill.; R. R. Cowles, Pacific Gas and Electric Company, San Francisco, Calif.; J. Allen Johnson, Buffalo, Niagara and Eastern Power Corporation, Buffalo, N. Y.; T. H. Haines, Edison Electric Illuminating Company, Boston, Mass.; *alternate*, A. B. Campbell, National Electric Light Association, New York City

U. S. Bureau of Standards—Arthur Halsted, Bureau of Standards, Washington, D. C.; *alternate*, P. H. Bates, Structural Materials Division, Bureau of Standards, Washington, D. C.

Corning Glass Works—J. T. Littleton, Corning Glass Works, Corning, N. Y.

Nomenclature and Methods of Test of Petroleum Products

The International Standards Association, of which body the American Standards Association is a member, decided in 1930 that an international technical committee should be organized to discuss the possibility of arriving at international uniformity between national standards on Nomenclature and Methods of Test of Petroleum Products. The secretariat for the international work was assigned to and accepted by ASA. This acceptance was based on the attitude regarding this project of the major American groups interested, and more particularly of the sectional committee on Methods of Testing Petroleum Products and Lubricants (Z11) and its sponsor body, the American Society for Testing Materials.

An active start in the work is now being made by ASA, which is sending out invitations to take part in the work of the new ISA technical committee to all Member-Bodies of the ISA and also to the three national standardizing bodies which are non-members of the ISA; namely, the British, Canadian, and Australian organizations. In fact, British cooperation has already been in effect for some years through two British members on the sectional committee. Dr. R. P. Anderson, secretary of sectional committee Z11 and secretary of the Division of Refining of the American Petroleum Institute, has been appointed by ASA to be the American representative on the ISA technical committee. In the letter of invitation to the foreign national bodies, a review is given of the American developments in the field, and the foreign bodies desirous of taking part in the work are invited to make a similar statement in regard to the work that has been done in their respective countries. The intention is to digest this information so that it may be used as a basis for developing a program of work for the international project.

R. H. Colley New Chairman of Wood Poles Committee

Notice has been received from the Telephone Group, sponsor for the project on Specifications for Wood Poles (O5), that the resignation of R. L. Jones, Bell Telephone Laboratories, New

York, chairman of the sectional committee, has been accepted. Mr. Jones has served as chairman of the committee since April, 1928. During his chairmanship, specifications and dimensions for the following species of wood poles were approved as American Standards:

Northern White Cedar Poles
Western Red Cedar Poles
Chestnut Poles
Southern Pine Poles

Dr. R. H. Colley, of the Timber Products Section, Outside Plant Development Department, Bell Telephone Laboratories, New York, who has served as vice-chairman since January, 1929, has been appointed by the sponsors to succeed Mr. Jones as chairman.

New Symbols Standard Submitted to ASA for Approval

The proposed standard Symbols for Mechanics, Structural Engineering, and Testing Materials (Z10a) has been submitted to ASA for approval as American Standard by the sectional committee on Scientific and Engineering Symbols and Abbreviations (Z10). This submission follows approval by the sectional committee and the five sponsors: the American Association for the Advancement of Science, the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Society of Mechanical Engineers, and the Society for the Promotion of Engineering Education.

Personnel of Drain Tile Committee Revised

The recent establishment of the new Bureau of Agricultural Engineering in the U. S. Department of Agriculture has affected the listing of certain members of the sectional committee on Specifications for Drain Tile (A6). S. H. McCrory, now director of the new bureau, represents only the American Society of Agricultural Engineers rather than both this organization and the Department of Agriculture as formerly. The Bureau of Public Roads no longer desires representation, and D. G. Miller, who formerly represented that Bureau on the committee, now represents the Bureau of Agricultural Engineering.

Committee Reports Possible Revision in Petroleum Standards

The American Society for Testing Materials, the sponsor for the project Methods of Testing Petroleum Products and Lubricants (Z11), advises that the sectional committee in charge of this project is considering minor revisions in the following American Standards:

	ASA	*A.S.T.M.*
Methods of Test for Viscosity of Petroleum Products and Lubricants	Z11b-1930	D88-30
Method of Test for Distillation of Natural Gas Gasoline	Z11k-1930	D216-30

Insulating Materials Standards Book Issued by A.S.T.M.

The American Society for Testing Materials has issued a compilation of its standards and tentative standards which relate to electrical insulating materials, together with the annual report of its Committee D-9 which functions in this field. The book comprises 209 pages.

There are included standard methods of testing molded materials used for insulation, electrical porcelain, and electrical insulating oils. Tentative methods are given for testing a large number of insulating materials such as varnishes, sheet, and tape (for dielectric strength), compounds used for splicing cables and filling potheads, untreated paper, varnished cloths and cloth tapes and laminated materials; also, tests for determining resistance to impact, resistivity, and thermal conductivities of insulating materials.

The specifications included cover friction tape, rubber insulating tape, rubber gloves, rubber matting, and asbestos tape. Also included are specifications for tests and tolerances of electrical cotton yarns, electrical silk and cotton tapes, and asbestos yarns.

There are, in addition to the standards mentioned above, others which involve materials used in the electrical insulating field. The price of the book is $1.25. It can be obtained from A.S.T.M. headquarters, 1315 Spruce Street, Philadelphia, or through the ASA office.

Sponsor Initiates Revision of Trolley Construction Standard

The American Electric Railway Association, proprietary sponsor for the project, has advised the American Standards Association that a revision of the American Standard Specification for 600 Volt Direct Current Overhead Trolley Construction (C15-1923), is being undertaken. The work is being done by the Power Committee of the A.E.R.A.